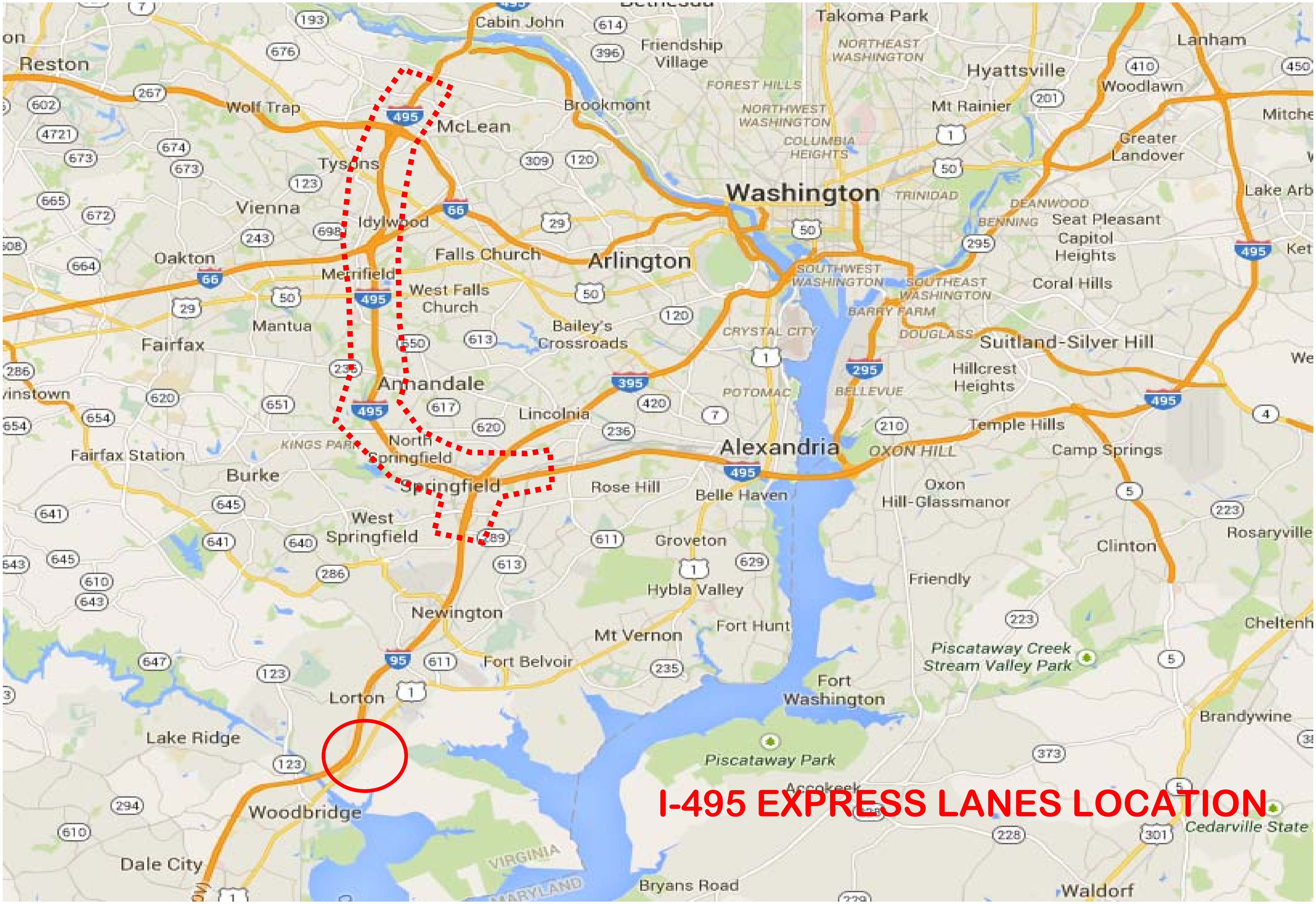
I-495 Capital Beltway Express Lanes Project

Challenges, Solutions, and Lessons Learned

J. Christopher Giese, P.E.

GeoVirginia



I-495 EXPRESS LANES LOCATION
Reston
Wolf Trap
McLean
Cabin John
Friendship Village
Brookmont
Takoma Park
NORTHEAST WASHINGTON
FOREST HILLS
NORTHWEST WASHINGTON
COLUMBIA HEIGHTS
Hyattsville
Mt Rainier
Woodlawn
Lanham
Greater Landover
Tysons
Vienna
Idylwood
Washington
TRINIDAD
DEANWOOD
BENNING
Seat Pleasant
Capitol Heights
Oakton
Merrifield
Falls Church
Arlington
SOUTHWEST WASHINGTON
SOUTHEAST WASHINGTON
Coral Hills
West Falls Church
BARRY FARM
Fairfax
Mantua
Bailey's Crossroads
CRYSTAL CITY
DOUGLASS
Suitland-Silver Hill
Hillcrest Heights
Annandale
POTOMAC
BELLEVUE
Lincolnia
Temple Hills
KINGS PARK
North Springfield
Alexandria
OXON HILL
Camp Springs
Fairfax Station
Burke
Springfield
Rose Hill
Belle Haven
Oxon Hill-Glassmanor
West Springfield
Groveton
Clinton
Rosaryville
Hybla Valley
Friendly
Newington
Mt Vernon
Fort Hunt
Piscataway Creek Stream Valley Park
Fort Belvoir
Fort Washington
Lorton
Lake Ridge
Brandywine
Piscataway Park
Woodbridge
Cedarville State
VIRGINIA
MARYLAND
Dale City
Bryans Road
Waldorf


Springfield
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SPRINGFIELD INTERCHANGE


I-95/I-395/I-495 INTERCHANGE (MIXING BOWL)
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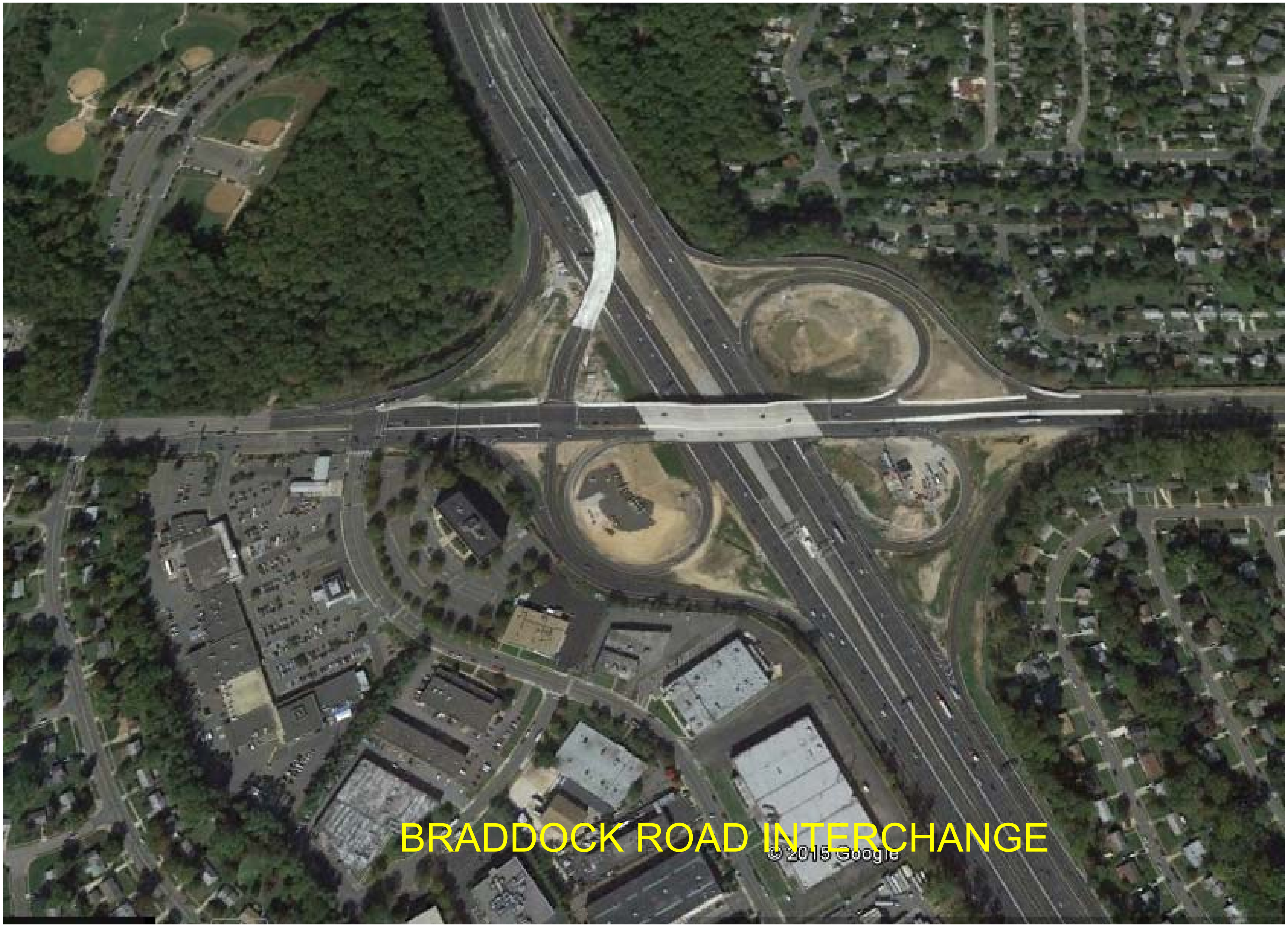
Goog


BRADDOCK ROAD INTERCHANGE
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LITTLE RIVER TURNPIKE INTERCHANGE


GALLOWS ROAD INTERCHANGE
© 2015 Google


ARLINGTON BOULEVARD INTERCHANGE


LEE HIGHWAY ON/OFF RAMP


I-66/I-495 INTERCHANGE
© 2013 Google


OAK STREET CROSSING
IDLEWOOD ROAD CROSSING
Idylwoo
© 2015 Google


LEESBURG PIKE INTERCHANGE


CHAIN BRIDGE ROAD INTERCHANGE


DULLES ACCESS ROAD INTERCHANGE
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SPRINGFIELD INTERCHANGE

APPROACHING THE MIXING BOWL

PASSING THROUGH THE MIXING BOWL

GOING NORTH ON I-495 THROUGH THE MIXING BOWL

DEAD CENTER IN THE MIXING BOWL

FIRST YOU HAVE TO PAY

BRADDOCK ROAD OVERPASS

BRADDOCK ROAD RAMP

LITTLE RIVER TURNPIKE OVERPASS

GALLOWS ROAD OVERPASS

I-66/I-495 INTERCHANGE

I-66/I-495 INTERCHANGE

APPROACHING LEESBURGE PIKE

LEESBURG PIKE OVERPASS

TYSONS TEE CONNECTOR

EXPRESS LANES VIADUCT OVER DULLES ACCESS ROAD

THEN YOU PAY AGAIN


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1998 Springfield Interchange Investigation

Prior Use of Shafts by VDOT was Limited

Geotech Report Developed Cost Analysis of Piles v. Shafts

- The use of shafts was about 25% less costly
- Shafts could carry more lateral load
- Shafts took about half the space
- VDOT accepted the design but wished for a test program

Initial 1998 Load Test Program

VDOT Retained Law Engineering to:

- Develop the program
- Prepare Special Provisions and Bid Package
- Monitor the Load Testing
- Evaluate the Results

Program Consisted of:

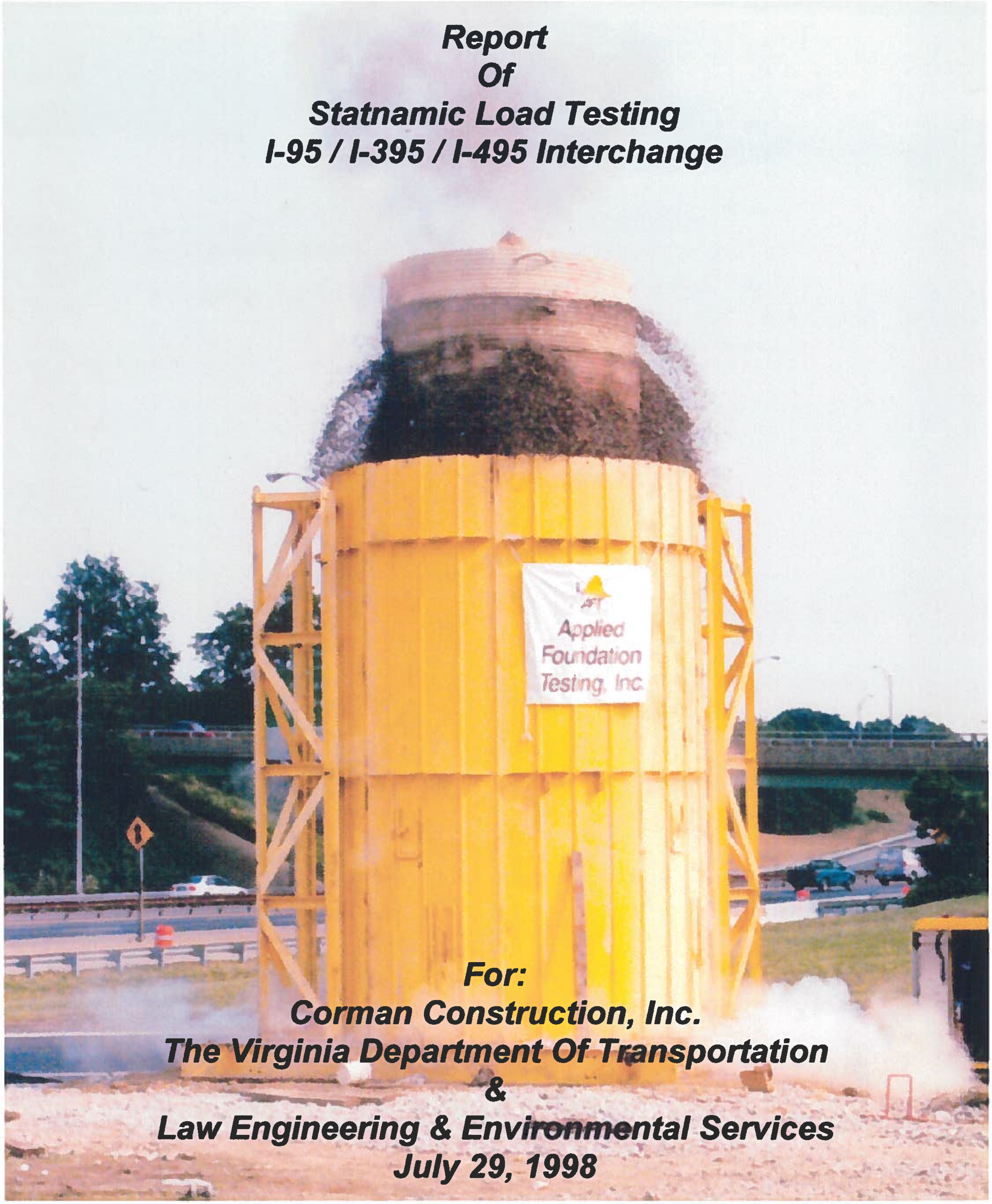
- Installing 5-foot diameter Drilled Shafts
- Two Shafts Bear in Rock and Tested with Ocells
- Two Shafts Bear in Weathered Rock and Tested with Ocells
- One Polymer Slurry Shaft Bearing in Rock and Tested by Statnamic
- One Lateral Load Test


W & OD Trail

Players

- Corman Construction
- Load Test, Inc (Ocell)
- Applied Foundation, Inc (Statnamic)
- VDOT
- Law Engineering

Report Of Statnamic Load Testing I-95 / I-395 / I-495 Interchange



For:

Corman Construction, Inc.

The Virginia Department Of Transportation

&

Law Engineering & Environmental Services

July 29, 1998

Drilled Shaft Load Test Results

Design Stress	**1998 Design SF = 2.5**	**Prelim. Rpt.**	**Phase VIII**	**I-495**
Allow. End Stress in Rock	5,750 kPa (120ksf)	100	115	None
Allow. End Stress in HWR	1,340 kPa (39 ksf)	25	None	30*
Allow. Side Stress in HWR	103 kPa (3 ksf)	3	None	3*
Allowable Side Stress in Soil	33 kPa (1 ksf)	1	None	1*

*Approximate Value – Actual value dependent on SPT value – Used Program SHAFT

Lateral test mimicked the LPILE prediction but deflection was about one-third less.

Rules for Drilled Shaft Design

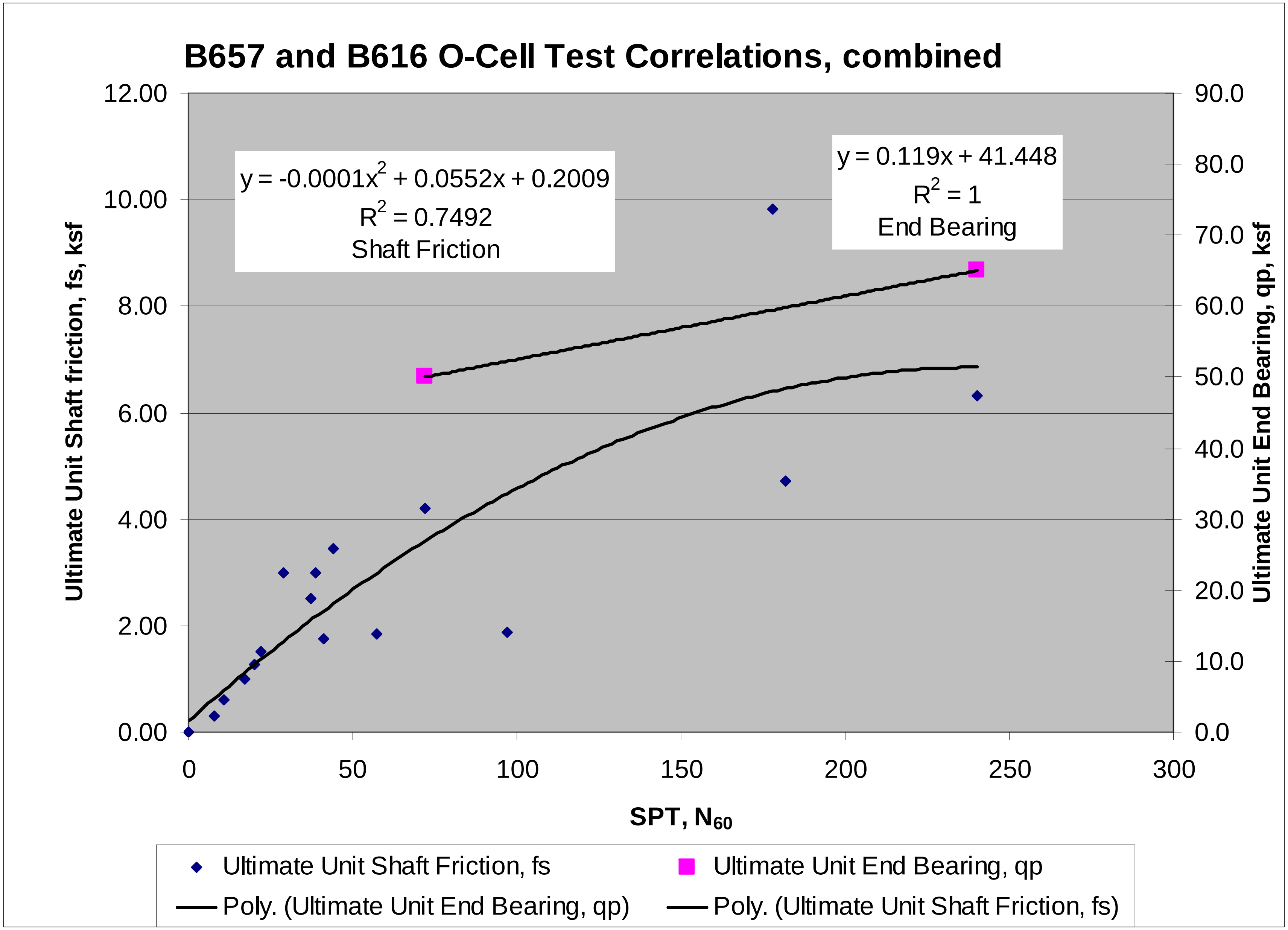
- Use Ensoft's SHAFT© for axial compression design of drilled shafts I-495, (regardless of installation technique).

- Shaft tips that bear in soil above HWR, must be designed based on shaft friction only – Ignore end bearing.

- Shafts bearing in HWR, tips must extend at least two shaft diameters into HWR, & at least one shaft diameter below a soil layer embedded into a larger HWR layer.

And More Rules

- A phi of 38 degrees used for end-bearing in HWR. The soil type is modeled as sand.
- The results of the O-Cell testing can influence the design if the correlations differ from the SHAFT© runs.
- Phase VIII shafts bearing in rock are to be designed as end bearing only. Tip resistances determined by AASHTO (Reese & O'Neil) design requirements based on the quality of the rock.


B657 and B616 O-Cell Test Correlations, combined
y = -0.0001x2 + 0.0552x + 0.2009
R2 = 0.7492
Shaft Friction
y = 0.119x + 41.448
R2 = 1
End Bearing
Ultimate Unit Shaft friction, fs, ksf
Ultimate Unit End Bearing, qp, ksf
SPT, N60
12.00
10.00
8.00
6.00
4.00
2.00
0.00
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0
50
100
150
200
250
300
Ultimate Unit Shaft Friction, fs
Ultimate Unit End Bearing, qp
Poly. (Ultimate Unit End Bearing, qp)
Poly. (Ultimate Unit Shaft Friction, fs)

Project Timelines

- Preliminary Rpt. completed in Fall 2007
- Project starts in 2008
- Giese moves to ECS April 2008
- ECS start Phase VIII in late May 2008
- ECS finishes Phase VIII ahead of schedule
- September 2008 I-495 geotechnical is well behind schedule (LD $21k/day)
- October 2008 ECS retained to complete geotechnical work
- January 2009 client institutes 100 in 100
- (approval reqd. to begin work)
- June 2010 most deliverables completed
- Heavy construction involvement through 2011
- November 17, 2012 Opening Day


BELT
HOW TO SPEND A MILLION DOLLARS A DAY


KOMATSU


MAGNUM


GANNETT
USA TODAY
USA TODAY
Link-Belt


CRANE RENTAL
TEREX
AMERICAN
05/11/2009 13:11

ECS CSL TESTING

ECS Mid-Atlantic, L
Geotechnical • Construction Materials • Environmental
4x4
DOMINION CAISSON
USDOT 400 754

ECS Mid-Atlantic, LLC
14026 Thunderbolt Place
Suite 100
Chantilly, VA 20151
Phone: 703-471-8400
Fax: 770-234-5805

Test Location Diagram

Project Name: I-495 HOT Lanes	Project Number: 0495-029-754
Project Location: Bridge B640 P2 S3 (CSL / Core Diagram)	Date: 01/21/2010

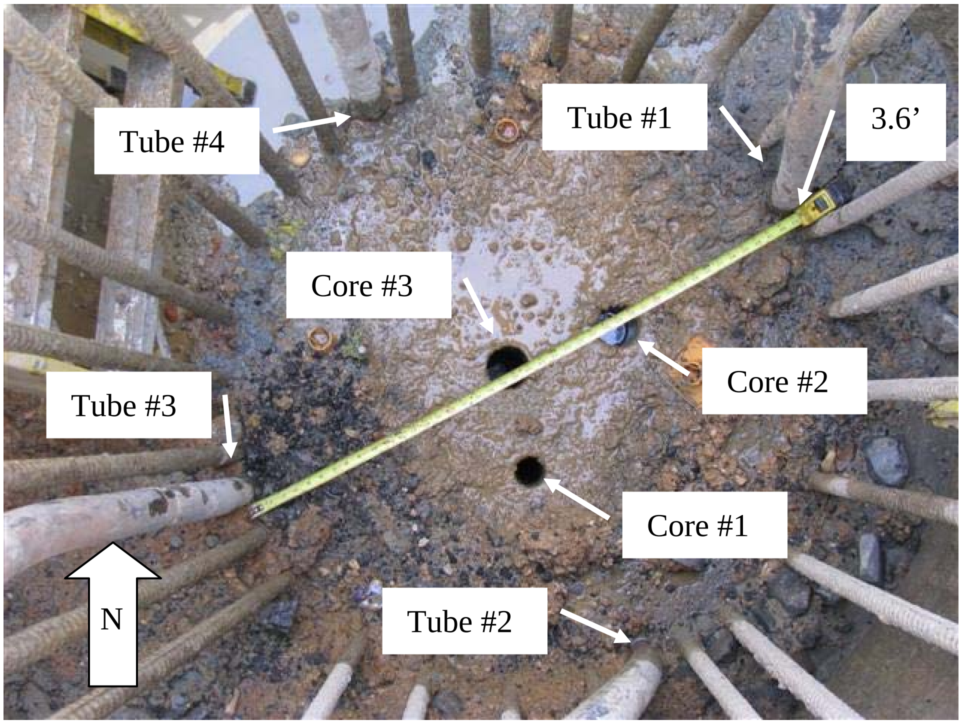


Photo 1. Core diagram showing CSL tubes and approximate North arrow

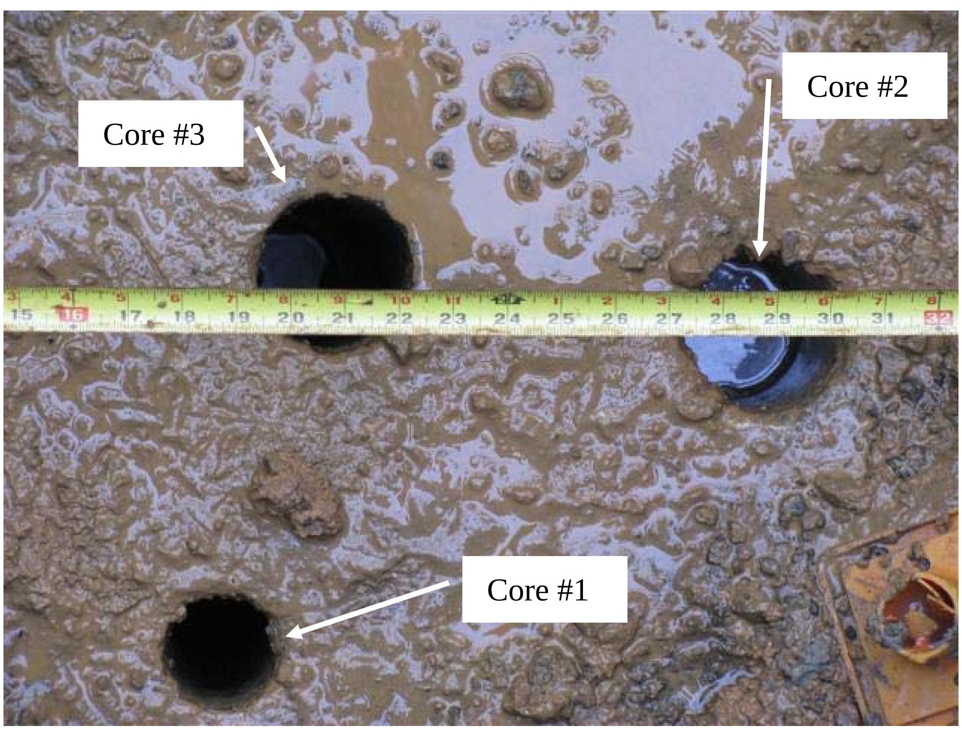
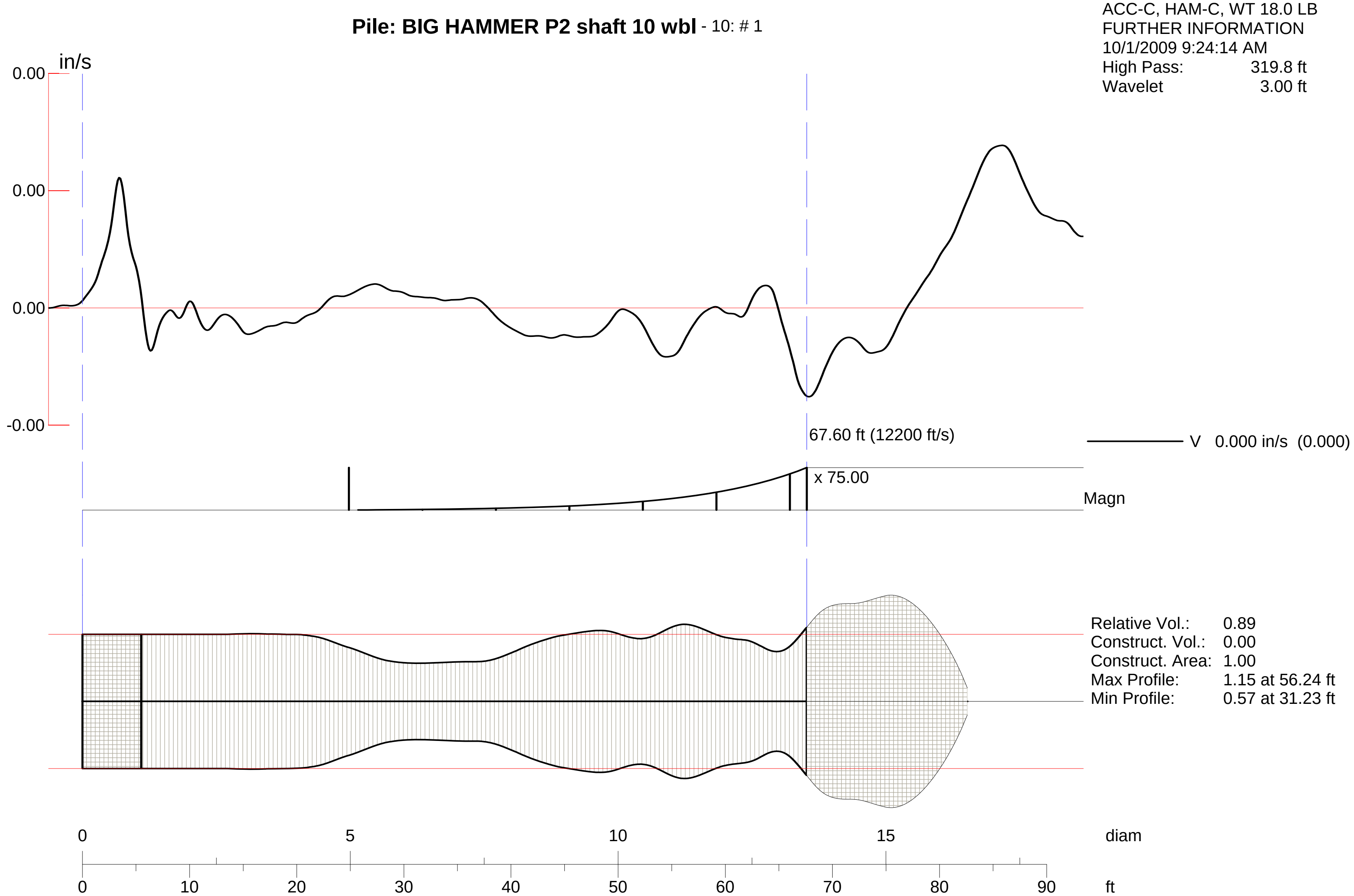


Photo 2. Core diagram

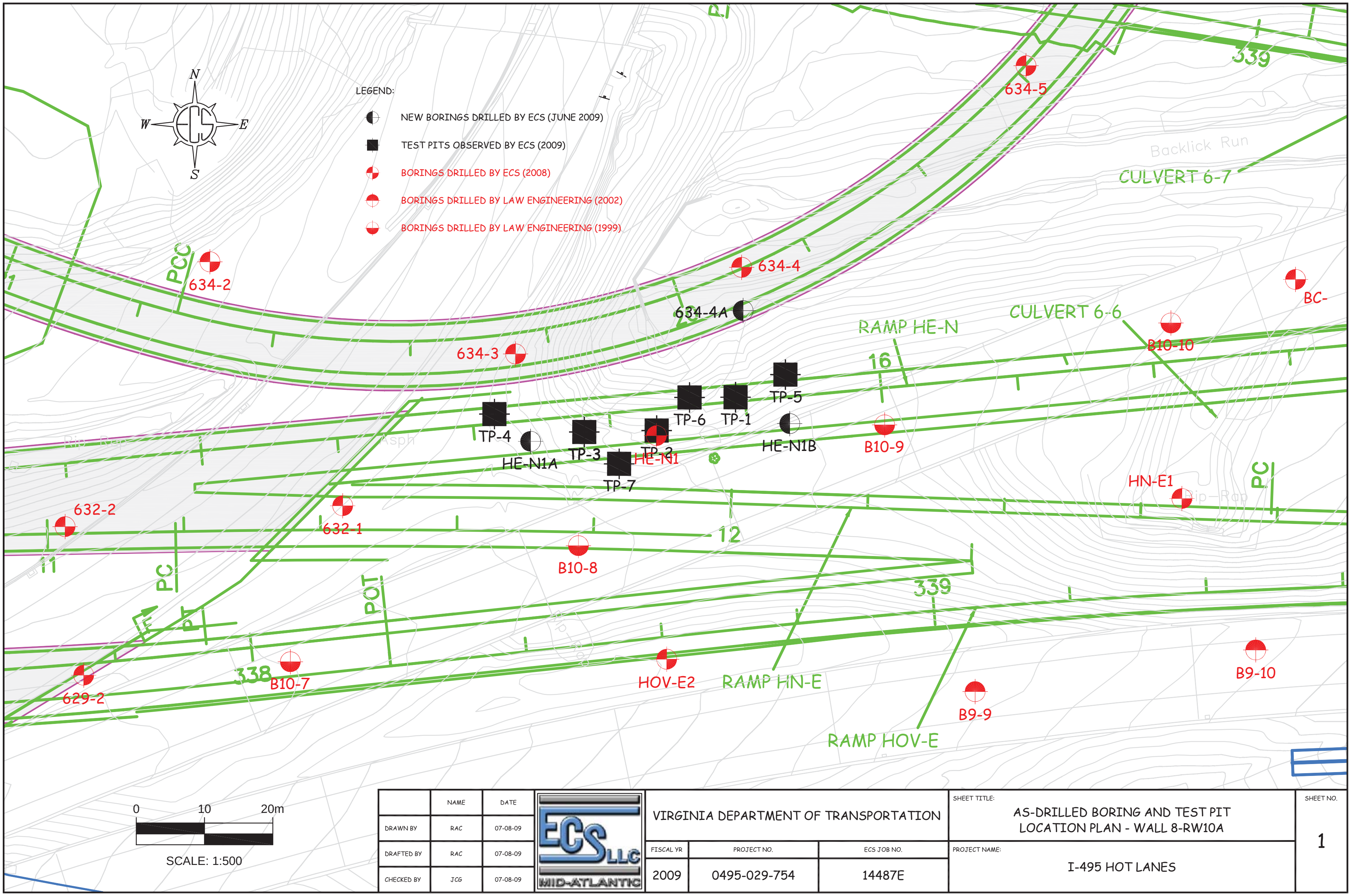

4 5 6 7 8 9 10 11 2F 1 2
5 16 17 18 19 20 21 22 23 24 25 26

ACC-C, HAM-C, WT 18.0 LB
FURTHER INFORMATION
10/1/2009 9:24:14 AM

High Pass:	319.8 ft	19.1 Hz
Wavelet	3.00 ft	2033.3 Hz



Relative Vol.:	0.89
Construct. Vol.:	0.00
Construct. Area:	1.00
Max Profile:	1.15 at 56.24 ft
Min Profile:	0.57 at 31.23 ft



RW-10A VCC GROUND IMPROVEMENT


RW-10A VCC GROUND IMPROVEMENT
05/11/2009 09:57
LASER SERVICES
Schnabel


05/11/2009 09:50

ROAD NO.	STATE	PROJECT NO.	FISCAL YR	SHEET NO.
I-495	VA	0495-029-754	2009	1

The subsurface information shown on the test pit logs in these plans was obtained with reasonable care and recorded in good faith solely for the use by the designer of record in establishing design controls for the project. The designer of record has no reason to suspect that such information is not reasonably accurate as an approximate indication of the subsurface conditions at the sites where the borings were taken. The designer of record does not in any way warrant or guarantee that such data can be projected as indicative of conditions beyond the limits of the test pits shown and any such projections by bidders are purely interpretive and altogether speculative. Further, the designer of record does not in any way guarantee, either expressly or by implication, the sufficiency of the information for bid purposes.

The test pit logs are made available to bidders in order that they may have access to subsurface data identical to those which are possessed by the designer of record and are not intended as a substitute for personal investigation, interpretation and judgement by the bidders.

KEY TO SOIL/ROCK SYMBOLS

Sampler Types: Grab Sample; Auger; Shelby Tube; SPT; Core

Other Symbols: CONV - Concrete PVT; ASPH - Asphalt PVT; FL - Fill; TOPS - Topsoil

Rock Types: BST - Basalt; GNS - Gneiss; DBS - Diabase; MYL - Mylonite; DRT - Diorite; PHY - Phyllite; HWR - Highly Weathered Rock; SCH - Schist; GRD - Grandiorite; SLT - Slate; GRN - Granite; CAV - Cavity

Unified Soil Classifications: Well Graded Gravel GW; Poorly Graded Gravel GP; Silty Gravel GM; Clayey Gravel GC; Well Graded Sand SW; Poorly Graded Sand SP; Silty Sand SM; Clayey Sand SC; SILT ML; Lean Clay CL; Lean Organic OL; Elastic Silt MH; Fat Clay CH; Elastic Organic OH; Peat PT

WATER LEVEL TIME OF DRILLING

WATER LEVEL STABILIZED

12 / 15 / 22 — SPT HAMMER BLOWS PER 6 in PENETRATION

100/3 — 100 BLOWS PER 3 in OF PENETRATION

ENGINEERING CLASSIFICATIONS

GRANULAR MATERIALS

RELATIVE DENSITY	SPT (BLOWS/FOOT)
VERY LOOSE	0-3
LOOSE	4-9
MEDIUM DENSE	10-29
DENSE	30-50
VERY DENSE	>50

SILTS AND CLAYS

CONSISTENCY	SPT (BLOWS/FOOT)
VERY SOFT	0-1
SOFT	2-4
FIRM	5-8
STIFF	9-15
VERY STIFF	16-30
HARD	30-50
VERY HARD	>50

MODIFIERS

MODIFIER	SOIL CONSTITUENT %
-Y	>30
WITH	15-30
TRACE	<15
CONTAINS	<30
HEAVY CONCENTRATIONS OF	>30

09BH-8RW10A TP-1 (PAGE 1 OF 1)

Virginia Department of Transportation — VDOT

PROJECT #: 095-080-111, PE 101
LOCATION: I-95/I-395/I-495 PHASE VIII
STRUCTURE: 8RW10A
STATION: 11+21.6 — OFFSET: 4
NORTHING: 38.79191211 — EASTING: -77.16931538
SURFACE ELEVATION: 55.66 m — COORD. DATUM: NAD 83

Date(s) Drilled: 5/11/09 - 5/11/09
Drilling Method(s): Test Pit
SPT Method:
Other Test(s):
Driller:
Logger: R. Khouri

GROUND WATER: FIRST ENCOUNTERED AT: 0.76 m

FIELD DATA columns: DEPTH (m); ELEVATION (m); SOIL: STANDARD PENETRATION TEST HAMMER BLOWS, % SOIL RECOVERY; SAMPLE LEGEND; SAMPLE INTERVAL; ROCK: % CORE RECOVERY, ROCK QUALITY DESIGNATION, DIP (STRATA, JOINTS); STRATA LEGEND. LAB DATA: LIQUID LIMIT (LL), PLASTICITY INDEX (PI), MOISTURE CONTENT (%)

Depth (m): 0.5, 1.0, 1.5, 2.0 — Elevation (m): 55, 54
Sample intervals: 0–0.15; 0.91–1.06; 1.22–1.37

DESCRIPTION OF STRATA

- 0.00 / 55.66 — Brown, clayey, fine to medium SAND (SC) with gravel, contains roots, cobbles, and wood debris, clay lenses, loose, moist, FILL FL
- SAME, perched water at 0.76 m
- 0.91 / 54.75 — Gray, brown, sandy, CLAY (CL), trace of gravel, contains wood, and organics, sand lenses, pocket penetration of 48 to 143 kPa, soft, moist, FILL FL
- 1.22 / 54.44 — Tan, brown, clayey, fine to medium SAND, trace of gravel, medium dense, moist, SC

REMARKS: Backfilled upon completion
N: 2125739.393
E: 3615599.819

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09BH-8RW10A TP-2 (PAGE 1 OF 1)

PROJECT #: 095-080-111, PE 101
LOCATION: I-95/I-395/I-495 PHASE VIII
STRUCTURE: 8RW10A
STATION: 11+33.4 — OFFSET: 6
NORTHING: 36.999999 — EASTING: -84.999999
SURFACE ELEVATION: 59.00 m — COORD. DATUM: NAD 83

Date(s) Drilled: 5/11/09 - 5/11/09
Drilling Method(s): Test Pit
Logger: R. Khouri

GROUND WATER: NOT ENCOUNTERED DURING DRILLING

Depth (m): 0.5–3.0 — Elevation (m): 58, 57, 56
Sample intervals: 0–0.15; 1.22–1.37; 3–3.15

DESCRIPTION OF STRATA

- 0.00 / 59.00 — Brown, gray, sandy CLAY (CL) with gravel, contains rootlets, wood, and heavy concentrations of construction debris to 0.76m, some sand lenses, pocket penetration of 0 to 48 kPa, very soft, moist, FILL FL
- SAME, pocket penetration of 96 kPa
- SAME, buried tree stump from 1.5 to 2.74 m
- 2.84 / 56.16 — Brown, clayey, fine to medium SAND, trace of gravel, contains mica, medium dense, moist, SC

REMARKS: Backfilled upon completion
Test pit elevation estimated from available topographic plan. Test pit northing, easting, and geodetic position not available.

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09BH-8RW10A TP-3 (PAGE 1 OF 1)

PROJECT #: 095-080-111, PE 101
LOCATION: I-95/I-395/I-495 PHASE VIII
STRUCTURE: 8RW10A
STATION: 11+45.5 — OFFSET: 3
NORTHING: 38.79187133 — EASTING: -77.16956689
SURFACE ELEVATION: 58.02 m — COORD. DATUM: NAD 83

Date(s) Drilled: 5/11/09 - 5/11/09
Drilling Method(s): Test Pit
Logger: R. Khouri

GROUND WATER: NOT ENCOUNTERED DURING DRILLING

Depth (m): 0.5–5.5 — Elevation (m): 57, 56, 55, 54, 53
Sample intervals: 0–0.15; 1.52–1.67

DESCRIPTION OF STRATA

- 0.00 / 58.02 — Brown, sandy CLAY (CL) with gravel, contains rootlets, wood, and heavy concentrations of construction debris (asphalt, brick, and concrete larger than 0.3m, reinforcing steel), pocket penetration of 48 kPa, very soft, FILL FL
- SAME, pocket penetration of 48 to 96 kPa, soft
- SAME, perched water at 2.13 m, wet
- 5.34 / 52.68 — Brown, sandy CLAY (CL) with gravel, contains some construction debris, firm, FILL FL

REMARKS: Backfilled upon completion, terminated in fill.
N: 2125734.551
E: 3615578.037

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09BH-8RW10A TP-4 (PAGE 1 OF 1)

PROJECT #: 095-080-111, PE 101
LOCATION: I-95/I-395/I-495 PHASE VIII
STRUCTURE: 8RW10A
STATION: 11+56.4 — OFFSET: 1.3
NORTHING: 38.79189447 — EASTING: -77.16972227
SURFACE ELEVATION: 59.69 m — COORD. DATUM: NAD 83

Date(s) Drilled: 5/11/09 - 5/11/09
Drilling Method(s): Test Pit
Logger: R. Khouri

GROUND WATER: NOT ENCOUNTERED DURING DRILLING

Depth (m): 0.5–5.0 — Elevation (m): 59, 58, 57, 56, 55
Sample intervals: 0–0.15; 3.05–3.2

DESCRIPTION OF STRATA

- 0.00 / 59.69 — Brown, clayey, fine to medium SAND (SC) with gravel, contains rootlets to 0.76 m, and heavy concentrations of debris (brick, concrete larger than 0.3m), medium dense, moist, FILL FL
- SAME, less debris from 1.22m
- SAME, fine to coarse
- SAME, trace debris from 3.96 m

REMARKS: Backfilled upon completion, terminated in fill.
N: [illegible]
E: [illegible]

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09BH-8RW10A TP-5 (PAGE 1 OF 1)

PROJECT #: 095-080-111, PE 101
LOCATION: I-95/I-395/I-495 PHASE VIII
STRUCTURE: 8RW10A
STATION: 11+12.5 — OFFSET: 2.3
NORTHING: 38.79194105 — EASTING: -77.16923081
SURFACE ELEVATION: 55.98 m — COORD. DATUM: NAD 83

Date(s) Drilled: 5/11/09 - 5/11/09
Drilling Method(s): Test Pit
Logger: R. Khouri

GROUND WATER: NOT ENCOUNTERED DURING DRILLING

Depth (m): 0.5–2.5 — Elevation (m): 55, 54
Sample intervals: 0–0.15; 1.52–1.67; 2.41–2.56

DESCRIPTION OF STRATA

- 0.00 / 55.98 — Brown, clayey, fine to medium SAND (SC) with gravel, contains rootlets to 0.76m, heavy concentrations of debris (concrete larger than 0.3m), and clay lenses, loose, moist, FILL FL
- 1.52 / 54.46 — Brown, sandy CLAY (CL), with gravel, contains heavy concentrations of construction debris (concrete larger than 0.3m), pocket penetration of 144 to 239 kPa, firm, moist, FILL FL
- SAME, with organics and roots at 1.83 m
- 2.41 / 53.57 — Brown, silty, fine to medium SAND (SM), trace of gravel, medium dense, moist, SM

REMARKS: Backfilled upon completion
N: [illegible]
E: [illegible]

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09BH-8RW10A TP-6 (PAGE 1 OF 1)

PROJECT #: 095-080-111, PE 101
LOCATION: I-95/I-395/I-495 PHASE VIII
STRUCTURE: 8RW10A
STATION: 11+26 — OFFSET: 8
NORTHING: 38.7919127 — EASTING: -77.16939301
SURFACE ELEVATION: 54.36 m — COORD. DATUM: NAD 83

Date(s) Drilled: 5/11/09 - 5/11/09
Drilling Method(s): Test Pit
Logger: R. Khouri

GROUND WATER: NOT ENCOUNTERED DURING DRILLING

Depth (m): 0.5–4.0 — Elevation (m): 54, 53, 52, 51
Sample intervals: 0–0.15; 1.83–1.98; 3.81–3.96

DESCRIPTION OF STRATA

- **0.00 / 54.36** — **Brown, clayey, fine to coarse SAND (SC), with gravel, contains rootlets to 0.76m, heavy concentrations of construction debris (concrete larger than 0.3m, reinforcing steel), clay lenses, medium dense, FILL FL**
- **1.83 / 52.53** — **Brown, sandy CLAY (CL), with gravel, contains heavy concentrations of debris (concrete larger than 0.3m, reinforcing steel), sand lenses, pocket penetration between 48 to 96 kPa, soft, moist, FILL FL**
- **3.81 / 50.55** — **Brown and gray, sandy CLAY, trace of gravel, silty sand layers, stiff, moist, CL**

REMARKS: Backfilled upon completion
N: [illegible]
E: [illegible]

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09BH-8RW10A TP-7 (PAGE 1 OF 1)

PROJECT #: 095-080-111, PE 101
LOCATION: I-95/I-395/I-495 PHASE VIII
STRUCTURE: 8RW10A
STATION: 11+39 — OFFSET: 11.8
NORTHING: 36.999999 — EASTING: -84.999999
SURFACE ELEVATION: 59.70 m — COORD. DATUM: NAD 83

Date(s) Drilled: 5/11/09 - 5/11/09
Drilling Method(s): Test Pit
Logger: R. Khouri

GROUND WATER: NOT ENCOUNTERED DURING DRILLING

Depth (m): 0.5–4.5 — Elevation (m): 59, 58, 57, 56
Sample intervals: 0–0.15; 2.77–2.92; 4.57–4.72

DESCRIPTION OF STRATA

- 0.00 / 59.70 — Brown, clayey, fine to medium SAND (SC) trace of gravel, contains heavy concentration of debris (concrete larger than 0.3m, reinforcing steel, asphalt), clay lenses, loose, moist, FILL FL
- Black, asphalt pavement sections, perched water above pavement, wet ASPH
- 2.77 / 56.93 — Brown, sandy CLAY (CL), trace of gravel, contains rootlets, construction debris, tree trunk at 4.3m, pocket penetration results between 0 to 47 kPa, very soft, wet, FILL FL
- 4.57 / 55.13 — Brown, clayey, fine to medium SAND, trace of gravel, medium dense, moist, SC

REMARKS: Backfilled upon completion
Test pit elevation estimated from available topographic plan. Test pit northing, easting, and geodetic position not available.

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	NAME	DATE
DRAWN BY	RAC	11-25-09
DRAFTED BY	RAC	11-25-09
CHECKED BY	JCG	11-25-09

ECS LLC MID-ATLANTIC

VIRGINIA DEPARTMENT OF TRANSPORTATION

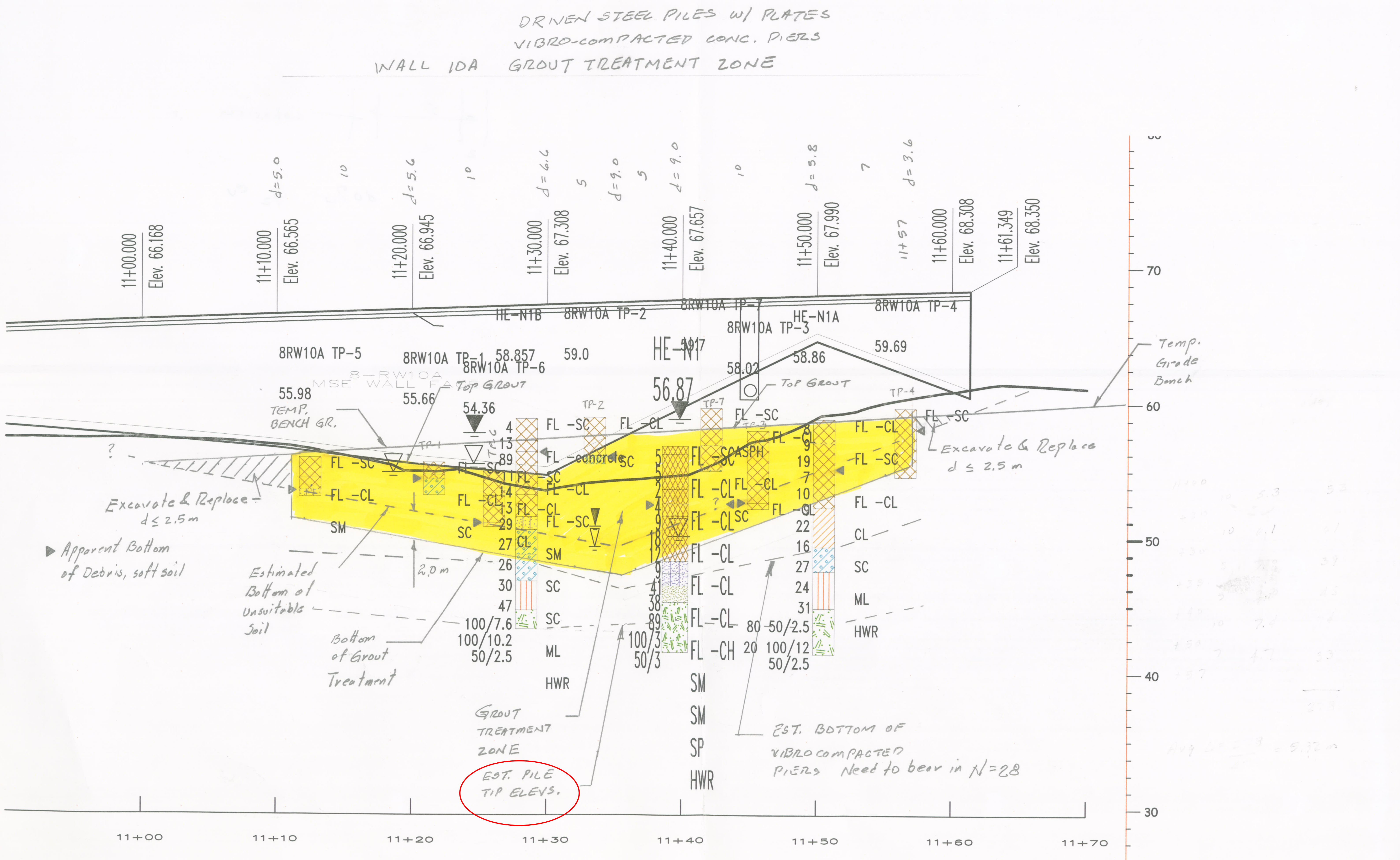
SHEET TITLE: GEOLOGY SHEET WALL 8-RW10A

ROAD NO.: I-495 — COUNTY: FAIRFAX CO. — ECS JOB NO.: 14487H

PROJECT NAME: I-495 HOT LANES

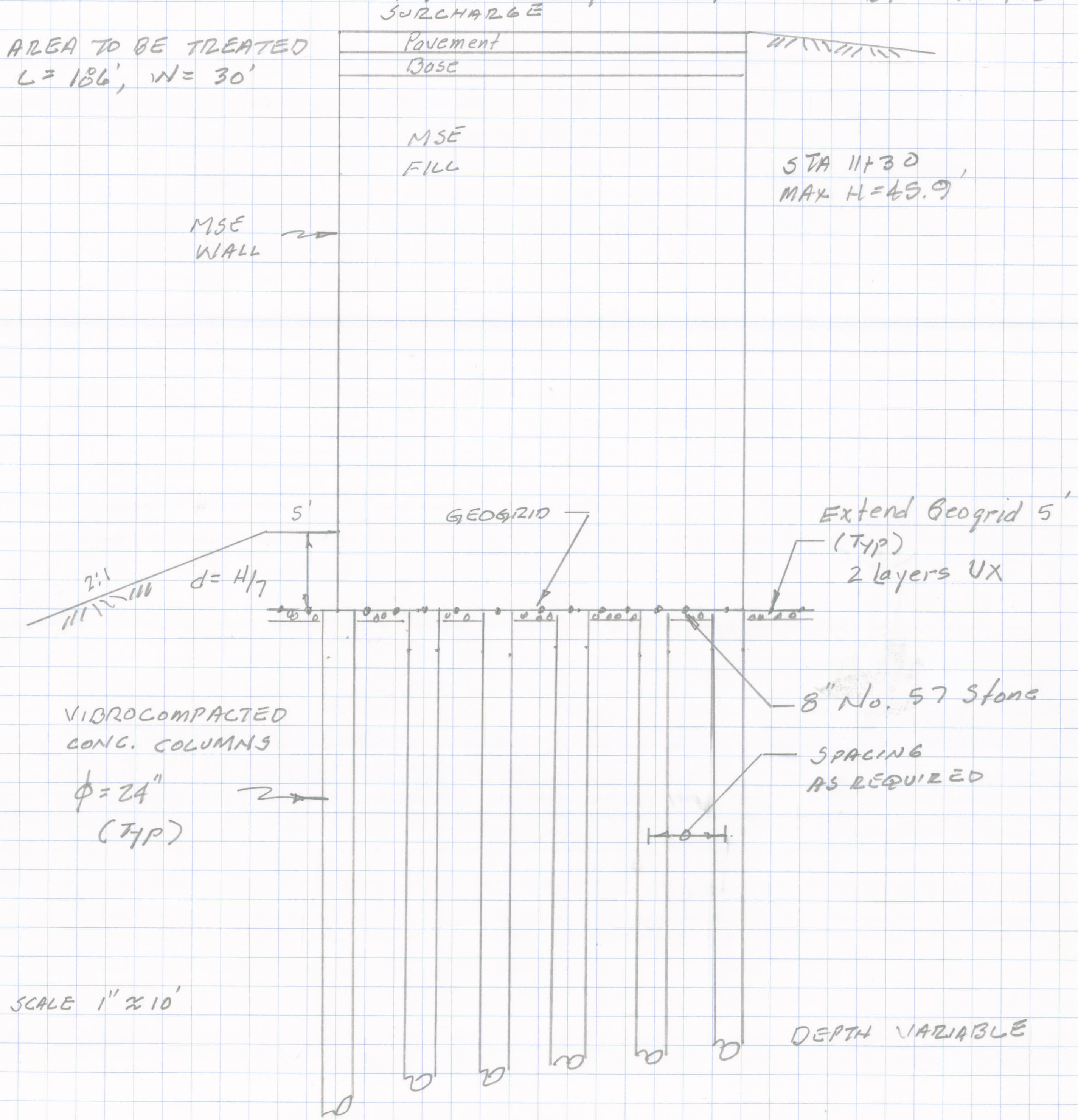
DRAWING NO.: 1

I:\Geotechnical\(eProjects)\14400-14499\01-14487\b-Drafting\Wall 10A\14487H_8RW10A_Geology.dwg, 11/30/2009 11:15:42 AM, ECS Mid-Atlantic, LLC Chantilly, VA.


DRIVEN STEEL PILES w/ PLATES
VIBRO-COMPACTED CONC. PIERS
WALL 10A GROUT TREATMENT ZONE
11+00.000 Elev. 66.168
11+10.000 Elev. 66.565
11+20.000 Elev. 66.945
11+30.000 Elev. 67.308
11+40.000 Elev. 67.657
11+50.000 Elev. 67.990
11+60.000 Elev. 68.308
11+61.349 Elev. 68.350
8RW10A TP-5
8RW10A TP-1
8RW10A TP-6
8RW10A TP-2
8RW10A TP-7
8RW10A TP-3
8RW10A TP-4
HE-N1B
HE-N1A
8-RW10A MSE WALL FACE
Top Grout
TEMP. BENCH GR.
Temp. Grade Bench
Excavate & Replace d ≤ 2.5 m
Apparent Bottom of Debris, soft soil
Estimated Bottom of Unsuitable Soil
Bottom of Grout Treatment
GROUT TREATMENT ZONE
EST. PILE TIP ELEVS.
EST. BOTTOM OF VIBRO COMPACTED PIERS Need to bear in N=28
2.0 m
11+00
11+10
11+20
11+30
11+40
11+50
11+60
11+70
70
60
50
40
30

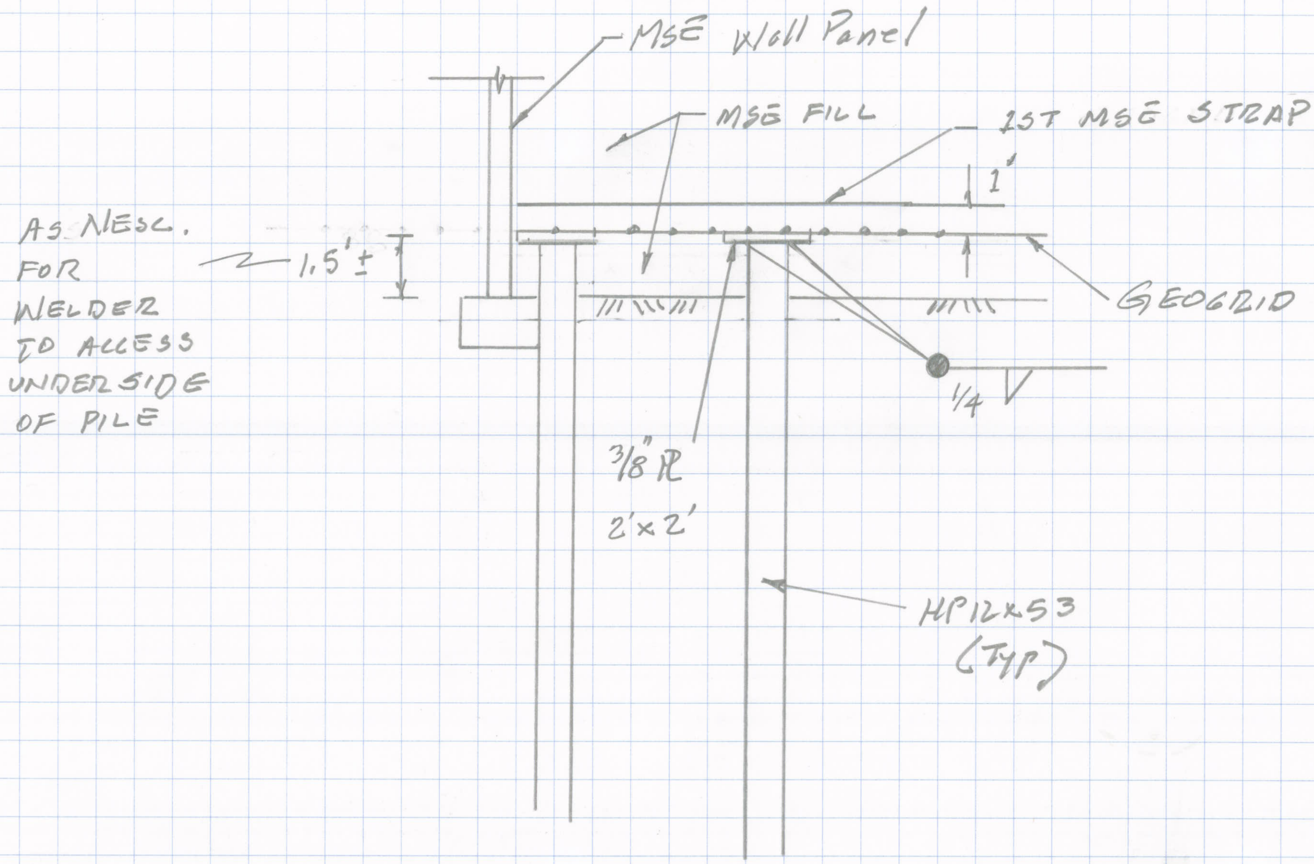
ECS LLC MID-ATLANTIC CALCULATION SHEET	PROJECT: HOT LANES SECT 8			FIGURE NO. 1
	TITLE: WALL 10A VIBROCOMPACTED CONC. PIERS			JOB NO. 14487
				SCALE:
	BY: JCG	DATE: 8-11-09	APPROVED BY: KAH	DATE 8/13/09

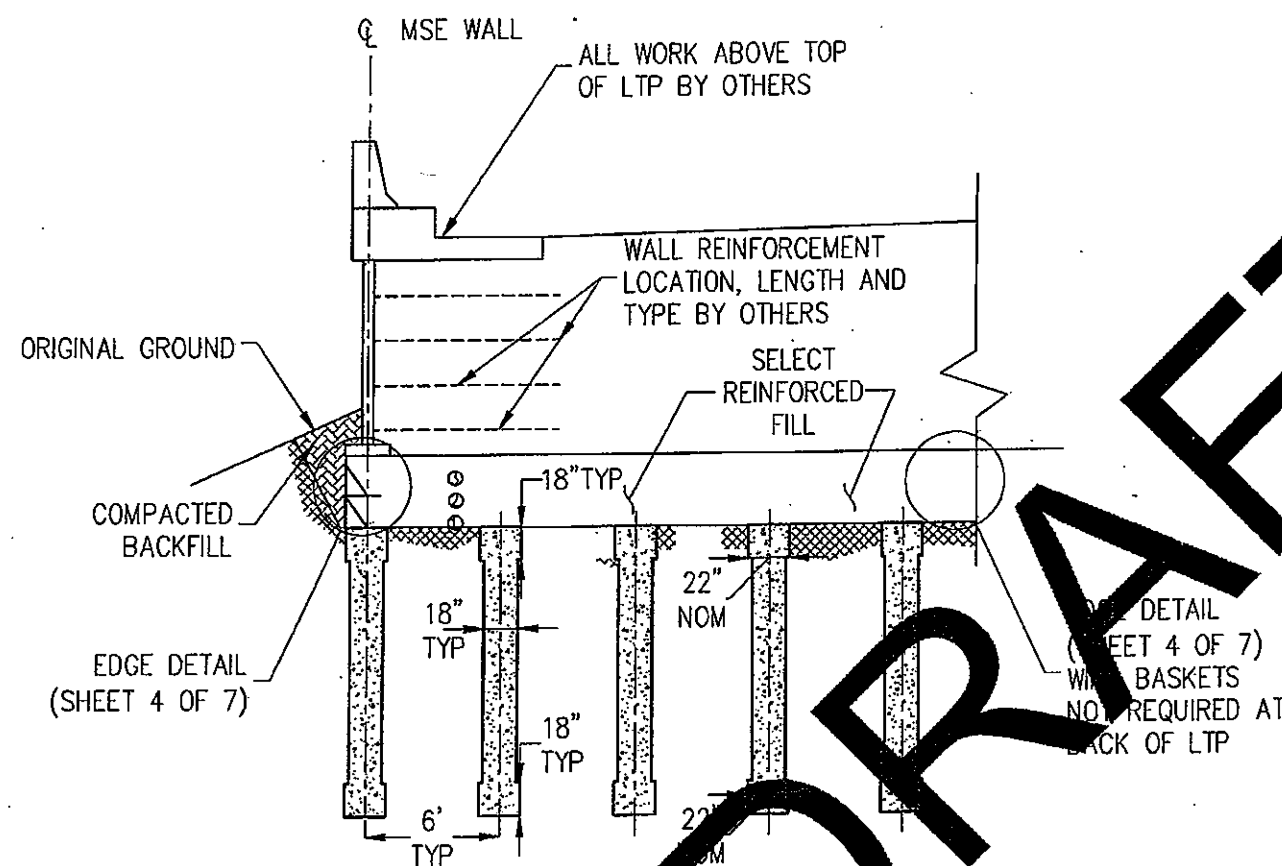
★ THESE ARE FEASIBILITY CALCS TO ASSESS THE FEASIBILITY OF VIBROCOMPACTED PIERS OR DRIVEN PILES. THE SPECIALTY CONTRACTOR SHALL SUBMIT SHOP DRAWINGS & CALCS PREPARED BY A VA P.E.



ECS LLC MID-ATLANTIC
CALCULATION SHEET

PROJECT: HOT LANES			FIGURE NO. 7
TITLE: PILES WALL 8-RW10A			JOB NO. 14487
			SCALE:
BY: JCG	DATE: 8-13-09	APPROVED BY:	DATE





LEGEND

Biaxial Geogrid Laid Perpendicular to Wall Face

Biaxial Geogrid Laid Parallel to Wall Face

Compacted Backfill

Existing Ground

① Structural Geogrid Layer Number

H5 VCC Label - See Sheet 3 of 7

Structural Geogrid Elevations For All Stations Within Level 1

① = (Tensar BX1100) ② = (Tensar BX1100)

③ = (Tensar BX1100)

NOTES:

1. See Reinforced Earth Company shop drawings for MSE Retaining Wall locations and dimensions.
2. Vibro-Concrete Column (VCC) design is the responsibility of Hayward Baker Company. The Collin Group, Ltd. shall be notified of any modifications to the VCC diameter or spacing from that shown on these plans.

THE COLLIN GROUP LTD
7445 Arlington Road
Bethesda, MD 20814
Telephone: 301.907.9501
Fax: 301.907.9502
Email: jim@thecollingroup.com

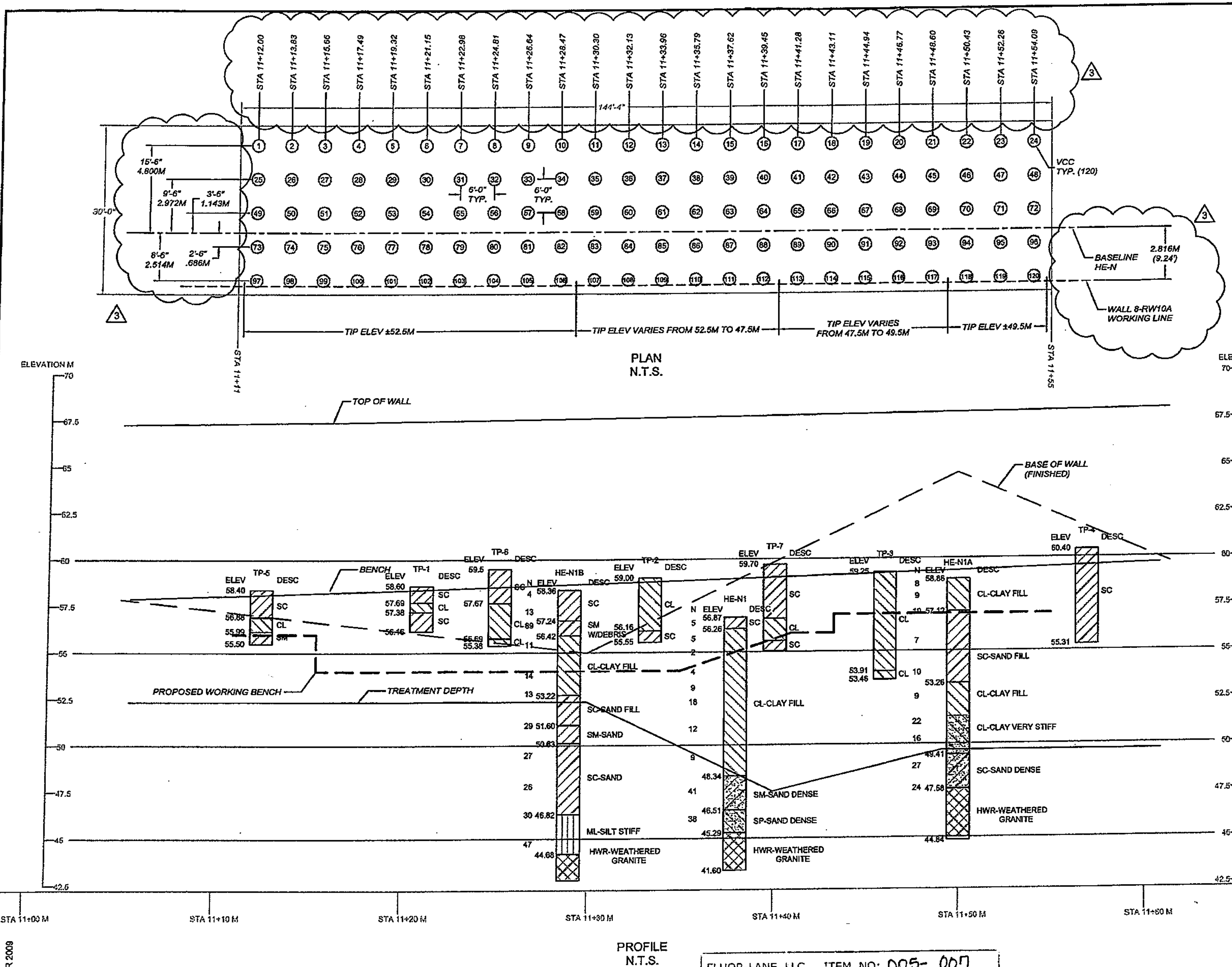
REVISIONS / DATES	
11/11/09	ISSUED FOR REVIEW

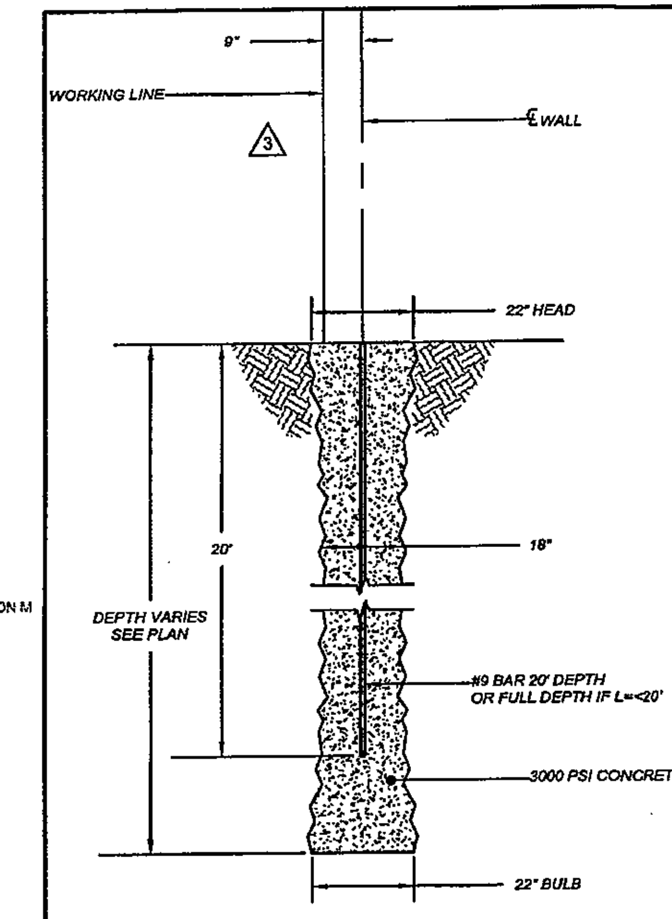
Date Drawn: 11/6/09
Scale: AS SHOWN
Designed By: JGC
Drawn By: KRM
Checked By: JGC

TYPICAL SECTION
MSE WALL 8-RW10A
LOAD TRANSFER PLATFORM

HNTB Corporation
Arlington, Virginia

Sheet Number: 3 of 7





TYPICAL VCC DETAIL
PROFILE
N.T.S.

005
RECEIVED
NOV 19 2009
FLUOR-LANE, LLC

COMMONWEALTH OF VIRGINIA
ALLEN L. SEHN
Lic. No. 18812
11/17/09
PROFESSIONAL ENGINEER

FLUOR-LANE, LLC ITEM NO: 005-007
SUBMITTAL PKG. NO: 0065-00506-00
ENGR: Wallace A by SLD DATE: 11/20/09

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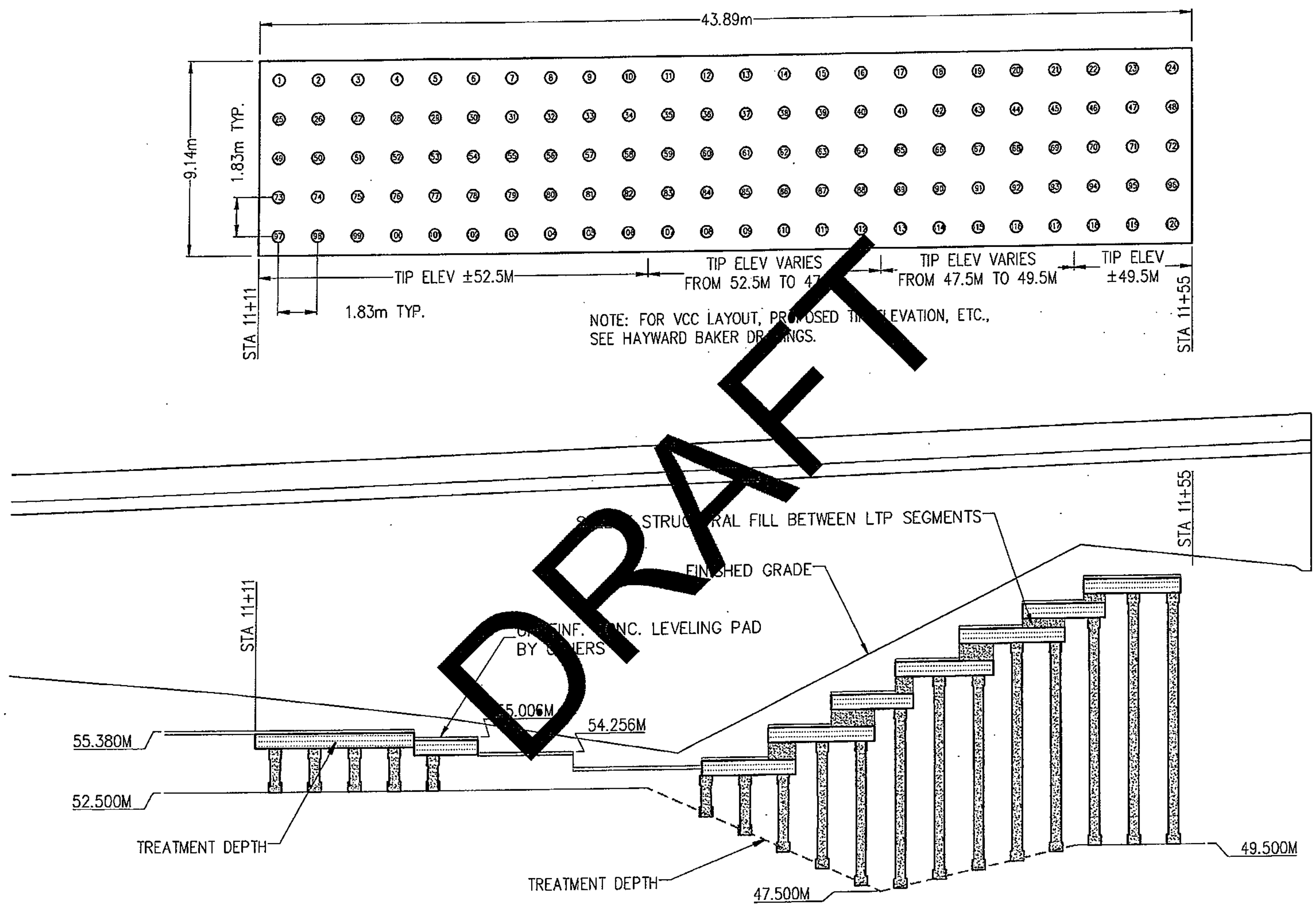
REV No.	DESCRIPTION	REV DATE	REV BY
3	BASELINE AND WALL WORKING LINES ADDED/VCC ROW DIMENSIONS/STATIONS ADDED	11/13/09	KCW
2	ADDED WORKING BENCH/TREATMENT STATIONS REVISED 11+11 TO 11+55/MODIFIED DETAIL	10/21/09	KCW
1	TYPICAL VCC DETAIL ADDED	KCW	9/23/09

TITLE	MSE EMBANKMENT WALL 10-A VCC LAYOUT PLAN and PROFILE
PROJECT	HOT LANES I-395 and I-495
DRAWING DATE	9/18/09
DRAWING No.	14698-001
SHEET	
REV. No.	3
DESIGNED BY	JTB/KCW
DRAWN BY	JHP
SCALE	N.T.S.
HB JOB No.	14698

HAYWARD BAKER
A Keller Company
Northeastern Region
1875 Mayfield Rd.
Odenton, MD 21113
Ph: (410) 551-1980
Fax: (410) 551-8206



THE COLLIN GROUP LTD
7445 Arlington Road
Bethesda, MD 20814
Telephone: 301.907.9501
Fax: 301.907.9502
Email: jim@thecollingroup.com

REVISIONS / DATES	
11/11/09	ISSUED FOR REVIEW

Project Number
Date Drawn 11/6/09
Scale AS SHOWN
Designed By JGC
Drawn By KRM
Checked By JGC

VCC PLAN AND ELEVATION
MSE WALL 8-RW10A
LOAD TRANSFER PLATFORM

HNTB Corporation
Arlington, Virginia

Sheet Number
2 of 7


RW-6A CTAP GROUND IMPROVEMENT
JOHN DEERE
DEERE
Baldwin
Contracting

Virginia Department of Transportation — VDOT

PROJECT #: 0495-029-754, P101
LOCATION: I-495 HOT Lanes Sections 1 to 7
STRUCTURE: Wall 6-RW5

09BH-6RW5A2-B1

STATION: 12+95 B.L. Wall 6RW5A — OFFSET: 13.1' LT
LATITUDE: ° — LONGITUDE: °
SURFACE ELEVATION: 100.0 ft — COORD. DATUM: VDOT

Date(s) Drilled: 7/24/2009 - 7/27/2009
Drilling Method(s): 3 1/4" diameter HSA
SPT Method: Automatic Hammer
Other Test(s):
Driller: K. Kersh, Connelly Drilling
Logger: D. Bookbinder

GROUND WATER
FIRST ENCOUNTERED AT: 33.5 ft

Depth (ft)	Elevation (ft)	SPT Hammer Blows	% Soil Recovery	Sample Interval	Description of Strata	LL	PI	Moisture Content (%)	% Passing #200
0.0	100.0	1-1-3	100	0-1.5	0.0 / 100.0 Brown, sandy SILT, trace of gravel, soft, moist, (ML) FILL (FL)			18.2	
2.5		3-3-7	87	2.5-4	SAME, stiff			14.7	
5.0	95.0	4-4-2	40	5-6.5	5.0 / 95.0 Brown, silty fine GRAVEL, with sand, loose, moist, (GM) FILL (FL)			9.8	
7.0	93.0				7.0 / 93.0 Brown, sandy CLAY, trace of gravel, very soft, moist, (CL) FILL (FL)				
8.5		2-1-1	67	8.5-10		42	19	24.5	67.6
13.5		3-2-3	13	13.5-15	SAME, with quartz gravel, firm			19.0	
18.0	82.0	WOH-3-2	100	18.5-20	18.0 / 82.0 Brown, sandy elastic SILT, firm, moist, (MH)	67	45	52.6	71.7
22.0	78.0	2-2-2	100	23.5-25	22.0 / 78.0 Brown, silty fine to medium SAND, with silt, loose, moist, (SM)			40.9	
28.5		3-3-5	100	28.5-30				36.8	
33.5	66.5	4-5-6	27	33.5-35	33.5 / 66.5 Brown, SILT, with sand, stiff, wet, (ML)			51.4	
38.5		6-6	87	38.5-40				34.0	

REMARKS: BM: VDOT. RIG TYPE: CME 550B. Hammer efficiency = 90.4%. Caved depth at 15.0' on 7/24/2009. Before pulling augers water is at 33.5'. Boring Lost prior to survey. Base Station baseline based on wall station.

09BH-6RW5A2-B1

STATION: 12+95 B.L. Wall 6RW5A
OFFSET: 13.1' LT
LATITUDE: °
LONGITUDE: °
SURFACE ELEVATION: 100.0 ft
COORD. DATUM: VDOT

Date(s) Drilled: 7/24/2009 - 7/27/2009
Drilling Method(s): 3 1/4" diameter HSA
SPT Method: Automatic Hammer
Other Test(s):
Driller: K. Kersh, Connelly Drilling
Logger: D. Bookbinder

GROUND WATER
∇ FIRST ENCOUNTERED AT: 33.5 ft

DEPTH (ft)	ELEVATION (ft)	STANDARD PENETRATION TEST HAMMER BLOWS	% SOIL RECOVERY	SAMPLE INTERVAL	DESCRIPTION OF STRATA	LL	PI	MOISTURE CONTENT (%)	% PASSING #200
40		8		40					
43.5–45	55	3 6 12	87	43.5–45	SAME, exhibits relic rock structure, very stiff			30.9	
48.5–50	50	7 16 21	100	48.5–50	SAME, hard			21.3	
53.5–55	45	10 17 23	100	53.5–55				22.2	
58.5–60	40	9 13 16	100	58.5–60	SAME, very stiff			21.1	
63.5–65	35	8 14 21	100	63.5–65	SAME, hard			26.8	
68.5–70	30	8 10 12	67	68.5–70	SAME, very stiff			24.5	
73.5–75	25	10 17 27	100	73.5–75	SAME, hard			30.0	
75					Boring terminated at 75.0' on 7/24/2009.				

REMARKS: BM: VDOT. RIG TYPE: CME 550B. Hammer efficiency = 90.4%. Caved depth at 15.0' on 7/24/2009. Before pulling augers water is at 33.5'. Boring Lost prior to survey. Base Station baseline based on wall station.

Virginia Department of Transportation

VDOT

PROJECT #: 0495-029-754, P101
LOCATION: I-495 HOT Lanes Sections 1 to 7
STRUCTURE: Wall 6-RW5

STATION: 13+04 B.L. Wall 6RW5A
OFFSET: 13.1' LT
LATITUDE: 38.902813 °
LONGITUDE: -77.215602 °
SURFACE ELEVATION: 439.5 ft
COORD. DATUM: VDOT

Date(s) Drilled: 7/30/2009 - 7/31/2009
Drilling Method(s): 3 1/4" diameter HSA
SPT Method: Automatic Hammer
Other Test(s):
Driller: S. Martin, Connelly Drilling
Logger: K. Lippincott

GROUND WATER
FIRST ENCOUNTERED AT: 10.0 ft
STABILIZED AT: 23.2 ft on 8/3/09

FIELD DATA / LAB DATA

Sample Interval (ft)	Elevation (ft)	Standard Penetration Test Hammer Blows	% Soil Recovery	Liquid Limit (LL)	Plasticity Index (PI)	Moisture Content (%)	% Passing #200
0 - 1.5		1 - 1 - 2	80			15.7	
2.5 - 4	435	1 - 4 - 7	93			8.7	
5 - 6.5		7 - 3 - 7	87			19.8	
9.5 - 11	430	7 - 22 - 8	67			4.0	
13.5 - 15	425	1 - 1 - 2	53			9.2	
15 - 16.5			100	40	31		56.5
16.5 - 18.5			100	46	22		46.6
18.5 - 20	420	2 - 2 - 2	100			34.1	
23.5 - 25	415	1 - 2 - 3	87			39.6	
25 - 27			0				
27 - 28.5		2 - 1 - 2	93			40.8	
28.5 - 30.5	410		100				
30.5 - 32		3 - 4 - 6	93			39.2	
33.5 - 35	405	3 - 4 - 5	100			40.5	
38.5 -	400	1 - 3	80			33.5	

DESCRIPTION OF STRATA

0.0 / 439.5
Brown, SILT, with sand, gravel, soft, moist, (ML) FILL (FL)

SAME, stiff

5.5 / 434.0
Brown, black, sandy SILT, contains asphalt, from 5.5' to 6.0', stiff, moist, (ML) FILL (FL)

8.5 / 431.0
Brown, SILT, trace of sand, gravel, contains asphalt from 9' to 10', very stiff, moist, (ML) FILL (FL)

13.5 / 426.0
Brown, SILT with sand and gravel, very soft, moist, (ML) FILL (FL)

16.5 / 423.0
Brown, clayey fine to medium GRAVEL, with sand, very loose, moist (GC) FILL (FL)

18.5 / 421.0
Brown, elastic SILT, with sand and gravel, soft, moist, (MH)

Tube bent on gravel, no recovery

27.0 / 412.5
Brown, CLAY, trace of sand, soft, moist, (CL)

30.5 / 409.0
Brown, SILT, with sand, exhibits relic rock structure, stiff, moist, (ML)

SAME, red-brown

REMARKS: BM: VDOT. RIG TYPE: T2 Hammer efficiency = 78.8%.
Caved at depth 66.0' on 7/31/2009. Caved Depth at 51.2' on 8/3/2009. Station baseline based on wall station.
N:452754.966, E:3646559.217

Virginia Department of Transportation

PROJECT #: 0495-029-754, P101
LOCATION: I-495 HOT Lanes Sections 1 to 7
STRUCTURE: Wall 6-RW5

09BH-6RW5A2-B1A

STATION: 13+04 B.L. Wall 6RW5A
OFFSET: 13.1' LT
LATITUDE: 38.902813 °
LONGITUDE: -77.215602 °
SURFACE ELEVATION: 439.5 ft
COORD. DATUM: VDOT

Date(s) Drilled: 7/30/2009 - 7/31/2009
Drilling Method(s): 3 1/4" diameter HSA
SPT Method: Automatic Hammer
Other Test(s):
Driller: S. Martin, Connelly Drilling
Logger: K. Lippincott

GROUND WATER
FIRST ENCOUNTERED AT: 10.0 ft
STABILIZED AT: 23.2 ft on 8/3/09

FIELD DATA / DESCRIPTION OF STRATA / LAB DATA

DEPTH (ft)	ELEVATION (ft)	STANDARD PENETRATION TEST HAMMER BLOWS	% SOIL RECOVERY	SAMPLE INTERVAL	% CORE RECOVERY	ROCK QUALITY DESIGNATION	DIP STRATA	DIP JOINTS	DESCRIPTION OF STRATA	LL	PI	MOISTURE CONTENT (%)	% PASSING #200
40		5	100	40 - 42									
42		4 6 9	87	42 - 43.5								34.9	
44	395	5 6 9	87	43.5 - 45								28.8	
50	390	4 7 10	87	48.5 - 50					SAME, very stiff			30.4	
54	385	6 11 17	93	53.5 - 55								28.2	
60	380	4 5 11	100	58.5 - 60								38.4	
64	375	7 11 14	100	63.5 - 65					SAME, trace of sand			31.2	
70	370	10 13 17	80	68.5 - 70					SAME, with sand, hard			24.4	
74	365	16 23 35	100	73.5 - 75								24.0	
80	360	21 30	100	78.5					79.0 / 360.5			20.2	

REMARKS: BM: VDOT. RIG TYPE: T2 Hammer efficiency = 78.8%.
Caved at depth 66.0' on 7/31/2009. Caved Depth at 51.2' on 8/3/2009. Station baseline based on wall station.
N:452754.966, E:3646559.217

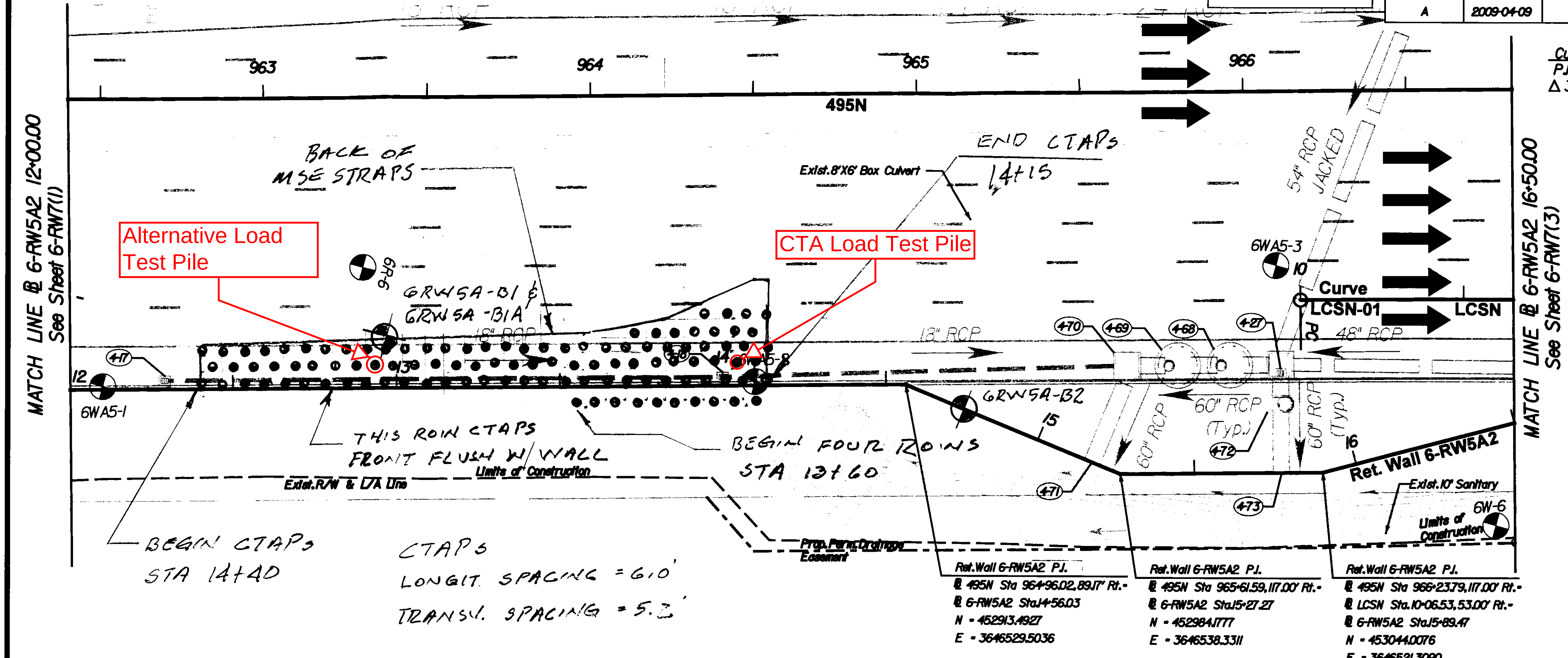
09BH-6RW5A2-B1A

IP_PWPdms22852\D368096-RW7(2).dgn [1-64.0-65]

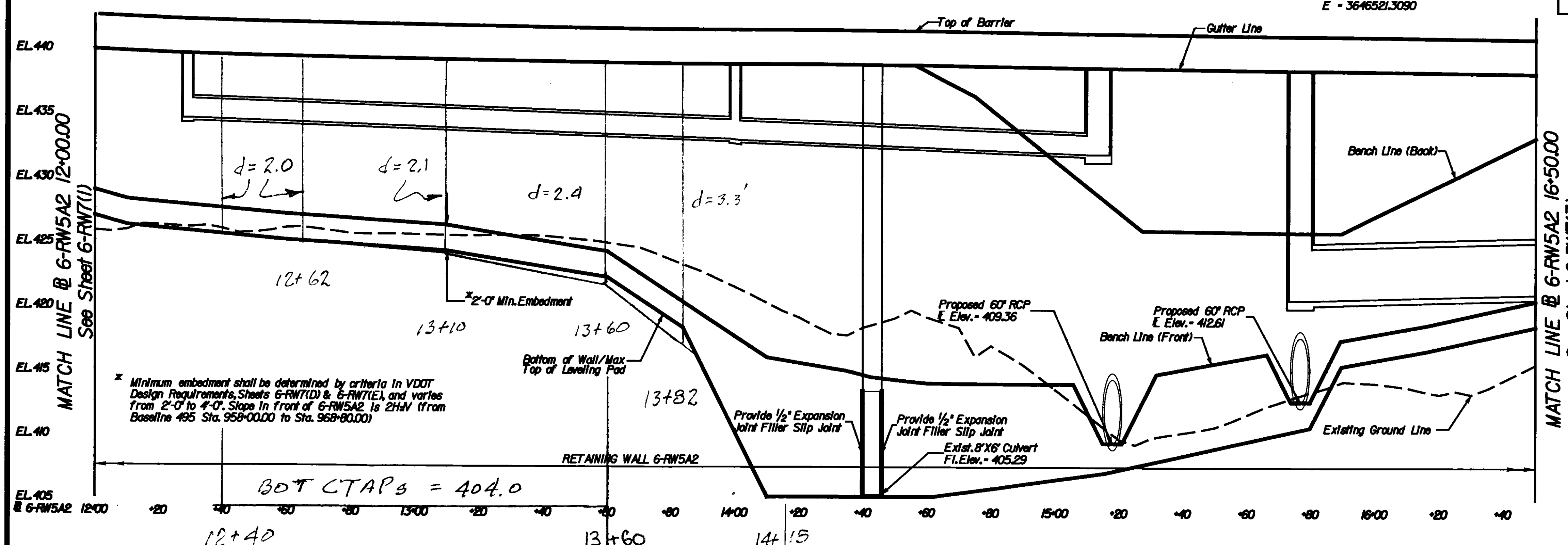
PROJECT MANAGER — LARRY CLOYED (571) 483-2600
SURVEYED BY — RICHARD ZIEMS (703) 631-5325
DESIGN SUPERVISED BY — CHARLES A.DODGE (703) 824-5100
DESIGNED BY — HNTB CORPORATION (703) 824-5100

THESE PLANS ARE UNFINISHED AND UNAPPROVED AND ARE NOT TO BE USED FOR ANY TYPE OF CONSTRUCTION

REVISION	DATE	FHWA REGION	STATE	FEDERAL AID PROJECT	ROUTE	STATE PROJECT	SHEET NO.
A	2009-04-09	3	VA.		495	0495-029-754,P101,C501	6-RW7(2)



STATION ℄ 6-RW5A2	BENCH LINE (FRONT)	GUTTER LINE	BOTTOM OF WALL /MAX TOP OF LEVELING PAD	BENCH LINE (BACK)
12+00.00	428.94	439.85		
12+25.00	427.89	439.56		
12+50.00	427.30	439.36		
12+75.00	426.81	439.22		
13+00.00	426.39	439.11		
13+25.00	425.62	439.00		
13+50.00	424.63	438.90		
13+75.00	421.76	438.81		
13+85.00	420.12	438.79	417.70	
14+00.00	417.65	438.77	410.20	
14+25.00	415.39	438.77	405.20	
14+50.00	414.29	438.70	405.20	
14+56.03	414.12	438.70	405.20	438.70
14+75.00	413.99	438.64	405.65	436.29
15+00.00	413.98	438.54	406.52	431.29
15+25.00	411.41	438.47	407.59	426.33
15+27.27	412.55	438.46	407.71	425.89
15+50.00	415.59	438.39	408.97	425.82
15+75.00	412.61	438.31	410.35	425.74
15+89.47	417.39	438.29	415.39	425.72
16+00.00	417.86	438.26	415.86	427.02
16+25.00	419.08	438.18		430.03
16+50.00	420.47	438.10		433.12



* Minimum embedment shall be determined by criteria in VDOT Design Requirements, Sheets 6-RW7(D) & 6-RW7(E), and varies from 2'-0" to 4'-0". Slope in front of 6-RW5A2 is 2H:1V (from Baseline 495 Sta. 958+00.00 to Sta. 968+80.00)

BOT CTAPS = 384.0

CEMENT - TREATED AGGREGATE PIERS (CTAPS)

For Plan Sheet Notes see sheet 6-RW7(I)

HORIZ. SCALE 0 20' 40'

VERT. SCALE 0 10' 20'

Rev.	Date	Description
A	2009-04-09	VDOT Final Review

MSE WALL

FLUOR-LANE

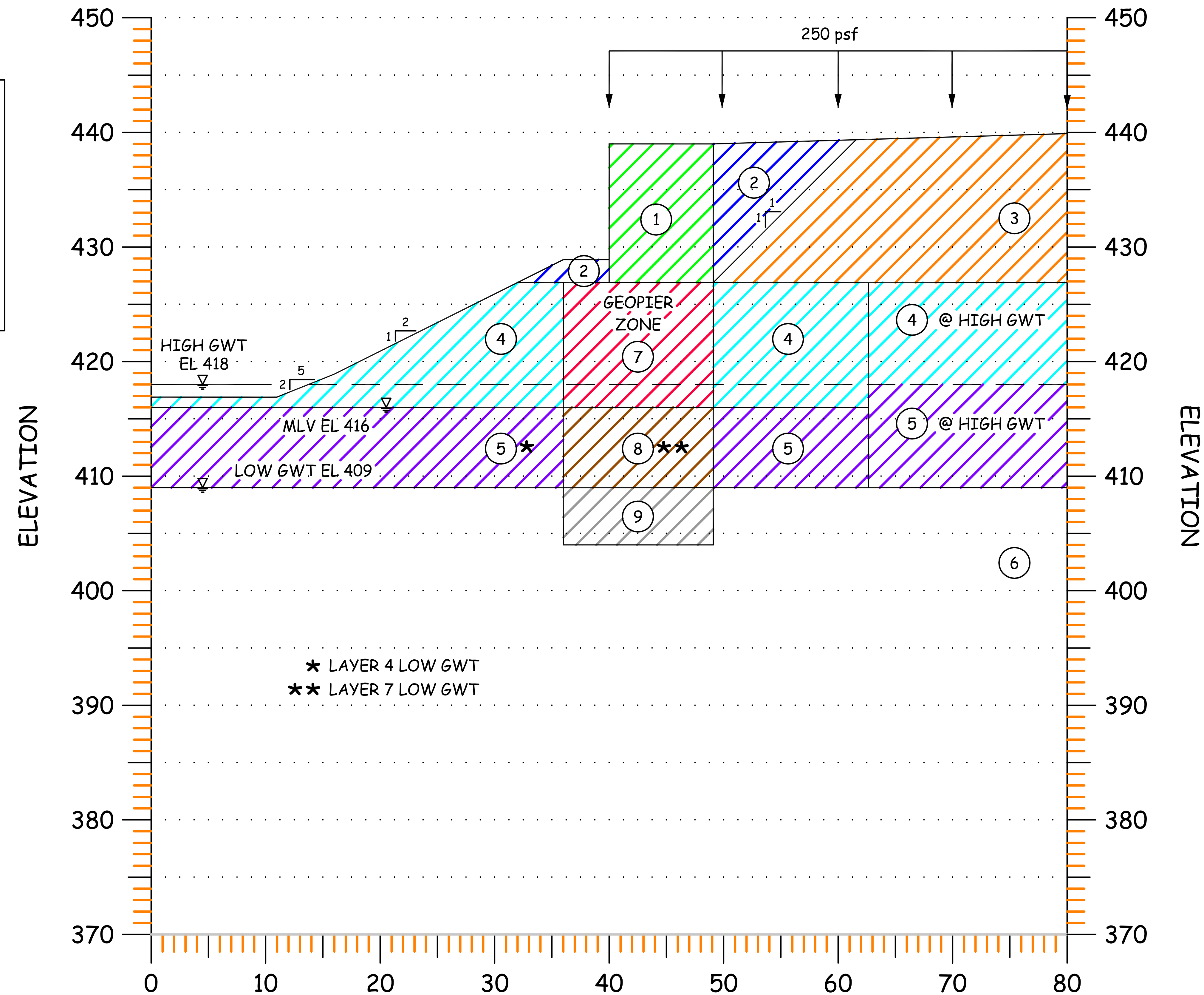
I-495 HOT LANES
RETAINING WALL 6-RW5A2
PLAN AND PROFILE
STA. 12+00.00 TO 16+50.00

HNTB CORPORATION
ARCHITECTS ENGINEERS & PLANNERS
ARLINGTON, VIRGINIA

Scale | Date April 9, 2009
PLAN NO. A | PROJECT | FILE NO. | SHEET NO. 6-RW7(2)

IP_PWPdms22852\D368096-RW7(2).dgn
4/9/2009 11:42:53 AM
Project - NONE
Pen Table - \\tcow00\CaddLib\Matt\Workspace\Agency\VDOT\Plot\36809-Hwy-36809_H.pen

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)
MSE (1)	1	110.0	117.0	0.0	34.0
BFILL(2)	2	118.0	125.0	50.0	30.0
II-A (3)	3	95.0	102.0	50.0	28.0
FL(4)	4	95.0	102.0	50.0	26.0
FL(5)sat	5	95.0	102.0	0.0	26.0
ML(6)	6	118.0	125.0	0.0	26.0
CTA(7)	7	104.5	110.2	1141	31.9
CTA(8)sa	8	104.5	110.2	1371	31.6
CTAML(9)	9	123.1	128.8	1371	33.7



SCALE
VERTICAL SCALE 1"=10'
HORIZONTAL SCALE 1"=10'

	NAME	DATE
DRAWN BY	RAC	09-21-09
DRAFTED BY	RAC	09-21-09
CHECKED BY	JCG	09-21-09

ECS LLC MID-ATLANTIC

VIRGINIA DEPARTMENT OF TRANSPORTATION

FISCAL YR	PROJECT NO.	ECS JOB NO.
2009		14487G

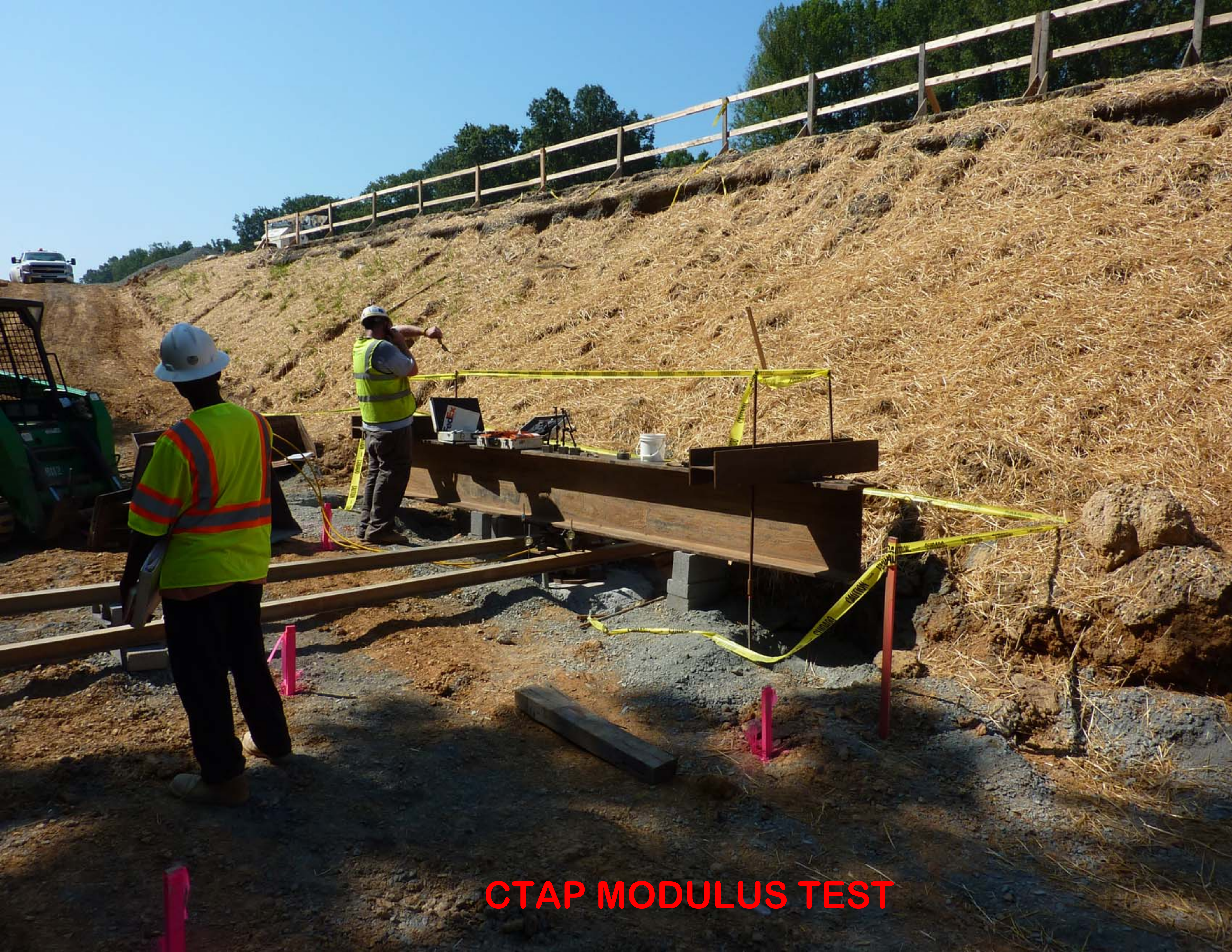
SHEET TITLE: 6RW5A-2 @ STA. 12+40 RELIABILITY LAYERS

PROJECT NAME: I-495 SECTION 6

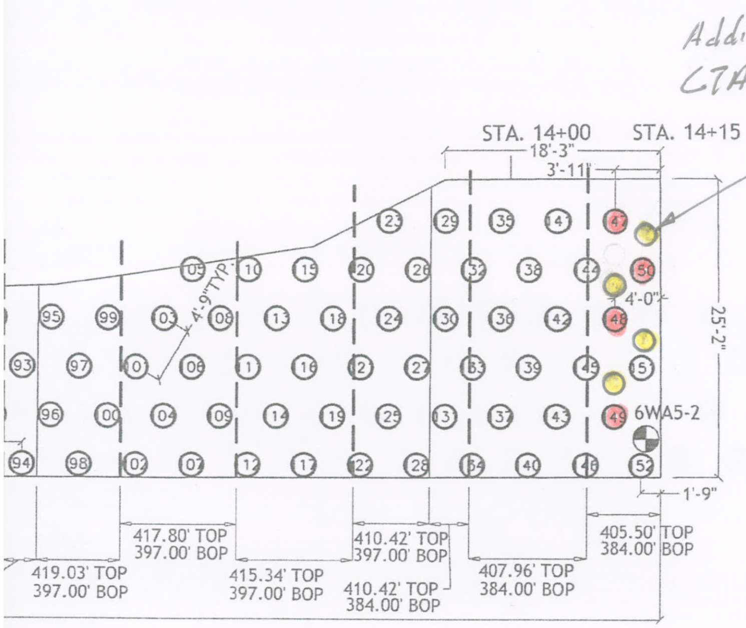
SHEET NO. 1

I:\Geotechnical\(eProjects)\14400-14499\01-14487-G\12 - Wall 6-RW5A\6RW5A Reliability Sta 12+40\6RW5A2_XSEC.dwg, 11/24/2009 8:40:05 AM, ECS Mid-Atlantic, LLC. Chantilly, VA.


200C LC



CTAP MODULUS TEST



North

LEGEND

PROPOSED TYP. 24" CEMENT TREATED AGGREGATE (CTA) GEOPIER ELEMENT

XXX APPROXIMATE BORING LOCATION

XXX.XX' TOP — TOP ELEV. (msl) OF CTA GEOPIER ELEMENTS

XXX.XX' BOP — BOTTOM ELEV. (msl) OF CTA GEOPIER ELEMENTS

NOTE:

1) All Geopier elements shall consist of Cement Treated Aggregate (CTA) and shall extend from the bottom of the wall/leveling pad elevation to the elevations shown on this plan.
2) Boring locations are shown for information only and are approximate locations taken from ECS-Mid-Atlantic, LLC dated June 11, 2009.
3) All existing and proposed utilities within and adjacent to the proposed retaining wall footprint shall be field verified by the General Contractor and coordinated with the CTA Geopier Foundation installer before CTA Geopier element installation shall proceed.
4) Any engineered fill required shall be placed and compacted in accordance with the Geotechnical Engineer of Record's (GER) requirements. All settlement as a result of fill placement shall be complete as determined by the GER prior to CTA Geopier element installation.
5) CTA Geopier elements that cannot be installed to their planned bottom of CTA Geopier element elevations, will be evaluated and design adjustments will be made on a case-by-case basis.
6) Construction notes and typical details are shown on sheet GP-2.

002
RECEIVED
AUG 24 2010
FLUOR-LANE, LLC

FLUOR-LANE, LLC ITEM NO: 002-003
SUBMITTAL PKG. NO: 0079-00506-03
ENGR: Jorie G bymy DATE: 8/24/10

0 8 16 32
SCALE: 1/16" = 1'

GeoStructures

GeoStructures, Inc.
413 Browning Court, Purcellville, VA 20132
phone: 703-771-9844
fax: 703-771-9847
e-mail: gsi@geostructures.com

Revision:	By:	Date:	Date Drawn: 08/20/2010
			Designed By: SMP
			Drawn By: SMP
DESIGN SUBMITTAL		08/20/2010	Checked By: VM

Project: CAPITAL BELTWAY HOT LANES I-495 PPTA
RW 6-RW5A2

Title: GEOPIER ELEMENT LAYOUT PLAN VIEW

Sheet: GP-1

Project No.: 5225 GP

RELIABILITY ASSESSMENT

Aggregate Pier /Matrix Weighted Average Shear Strength

Project I-495 RW 6RW5A2 12+40
Location Fairfax, VA

Equations: (FHWA/RD-83/0236; December, 1983; pp. 80-82)

(9) = (1) x (2) + (5) x (6)

(10) = (2) x (3) + (6) x (7)

(11) = atan[(1) x (2) x tan(4)+(5) x (6) x tan (8)] / (9)

	Units	Aggregate Pier Elements										Matrix Soil					Composite Weighted Average		
		Grid	#Rows	C.C. Spacing (ft)	Dia. (in)	#Ps/ Wall Foot	Zone Width (ft)	(1) Unit Wt., γ_{sc} (pcf)	(2) Area Ratio, A_{sc} (%)	(3) c_{sc}	(4) ϕ_{sc}°	Soil Type	(5) Unit Wt., γ_{soil} (pcf)	(6) Area Ratio, A_{soil} (%)	(7) c_{soil}	(8) ϕ_{soil}°	(9) Unit Wt., γ_{ave} (pcf)	(10) c_{ave}	(11) ϕ_{ave}°
MLV Layer 7	E	T	3	6.00	30	0.50	12.89	145	0.19	7200	45	CL/MH	95	0.81	50	26	104.5	1411.2	31.9
+Φ	E	T	3	6.00	30	0.50	12.89	145	0.19	7200	45	CL/MH	95	0.81	50	28.4	104.5	1411.2	33.5
-Φ	E	T	3	6.00	30	0.50	12.89	145	0.19	7200	45	CL/MH	95	0.81	50	23.6	104.5	1411.2	30.4
+C	E	T	3	6.00	30	0.50	12.89	145	0.19	7200	45	CL/MH	95	0.81	66	26	104.5	1424.1	31.9
-C	E	T	3	6.00	30	0.50	12.89	145	0.19	7200	45	CL/MH	95	0.81	35	26	104.5	1399.0	31.9
+δ	E	T	3	6.00	30	0.50	12.89	145	0.19	7200	45	CL/MH	100.9	0.81	50	26	109.3	1411.2	31.7
-δ	E	T	3	6.00	30	0.50	12.89	145	0.19	7200	45	CL/MH	89.1	0.81	50	26	99.7	1411.2	32.2
+Φ Agg	E	T	3	6.00	30	0.50	12.89	145	0.19	7200	49.2	CL/MH	95	0.81	50	26	104.5	1411.2	33.6
-Φ Agg	E	T	3	6.00	30	0.50	12.89	145	0.19	7200	40.8	CL/MH	95	0.81	50	26	104.5	1411.2	30.4
+δ Agg	E	T	3	6.00	30	0.50	12.89	154	0.19	7200	45	CL/MH	95	0.81	50	26	106.2	1411.2	32.2
-δ Agg	E	T	3	6.00	30	0.50	12.89	136	0.19	7200	45	CL/MH	95	0.81	50	26	102.8	1411.2	31.7
For global and all other cases except low gwt bearing capacity (Use layer 7 for Layer 8 low gwt)																			
MLV Layer 8	E	T	3	6.00	30	0.50	12.89	145	0.19	7200	45	CL/MH	102	0.81		26	110.2	1370.7	31.6
+Φ	E	T	3	6.00	30	0.50	12.89	145	0.19	7200	45	CL/MH	102	0.81		28.4	110.2	1370.7	33.3
-Φ	E	T	3	6.00	30	0.50	12.89	145	0.19	7200	45	CL/MH	102	0.81		23.6	110.2	1370.7	30.0
+C	E	T	3	6.00	30	0.50	12.89	145	0.19	7200	45	CL/MH	102	0.81		26	110.2	1370.7	31.6
-C	E	T	3	6.00	30	0.50	12.89	145	0.19	7200	45	CL/MH	102	0.81		26	110.2	1370.7	31.6
+δ	E	T	3	6.00	30	0.50	12.89	145	0.19	7200	45	CL/MH	104.5	0.81		26	112.2	1370.7	31.5
-δ	E	T	3	6.00	30	0.50	12.89	145	0.19	7200	45	CL/MH	99.5	0.81		26	108.2	1370.7	31.7
+Φ Agg	E	T	3	6.00	30	0.50	12.89	145	0.19	7200	49.2	CL/MH	102	0.81		26	110.2	1370.7	33.3
-Φ Agg	E	T	3	6.00	30	0.50	12.89	145	0.19	7200	40.8	CL/MH	102	0.81		26	110.2	1370.7	30.2
+δ Agg	E	T	3	6.00	30	0.50	12.89	154	0.19	7200	45	CL/MH	102	0.81		26	111.9	1370.7	31.9
-δ Agg	E	T	3	6.00	30	0.50	12.89	136	0.19	7200	45	CL/MH	102	0.81		26	108.5	1370.7	31.4
MLV Layer 9	E	T	3	6.00	30	0.50	12.89	145	0.19	7200	45	ML	125	0.81		30	128.8	1370.7	33.7
+Φ	E	T	3	6.00	30	0.50	12.89	145	0.19	7200	45	ML	125	0.81		34.6	128.8	1370.7	37.1
-Φ	E	T	3	6.00	30	0.50	12.89	145	0.19	7200	45	ML	125	0.81		28.6	128.8	1370.7	32.7
+C	E	T	3	6.00	30	0.50	12.89	145	0.19	7200	45	ML	125	0.81		30	128.8	1370.7	33.7
-C	E	T	3	6.00	30	0.50	12.89	145	0.19	7200	45	ML	125	0.81		30	128.8	1370.7	33.7
+δ	E	T	3	6.00	30	0.50	12.89	145	0.19	7200	45	ML	128.9	0.81		30	132.0	1370.7	33.7
-δ	E	T	3	6.00	30	0.50	12.89	145	0.19	7200	45	ML	121.1	0.81		30	125.6	1370.7	33.8
+Φ Agg	E	T	3	6.00	30	0.50	12.89	145	0.19	7200	49.2	ML	125	0.81		30	128.8	1370.7	35.1
-Φ Agg	E	T	3	6.00	30	0.50	12.89	145	0.19	7200	40.8	ML	125	0.81		30	128.8	1370.7	32.6
+δ Agg	E	T	3	6.00	30	0.50	12.89	154	0.19	7200	45	ML	125	0.81		30	130.5	1370.7	33.9
-δ Agg	E	T	3	6.00	30	0.50	12.89	136	0.19	7200	45	ML	125	0.81		30	127.1	1370.7	33.6
	Note this assumed that the Aggregate Pier will be cement treated such that the individual element shall have a cohesion of no less than 7200 psf.																		

	ENGINEERING CONSULTING SERVICES, LTD. COMPUTATION SHEET	Page 1 of 1 Made By JCG
ECS LLC MID-ATLANTIC	Reliability Assessment	Date 10/6/2009 Checked By RAK
	Location: Wall 6-RW5A2 Sta 12+40 Enter Values in Blue.	Date 10/6/2009

Type of Analysis Global Stability

Red Values Are Calculated Values.

FS Most Likely Value, F_{MLV}

Factor No.	Variable	OT & Sliding Cases							
1	Most Likely Values		See MLVs below						
2A	High GWT		See MLVs below		+gwt	421.0			
2B	Low GWT		See MLVs below		-gwt	409.0			
			Variable	Units					
3	MSE +γ		116.8	pcf	Use Most Likely Base Values, Except for Variable				
4	MSE -γ		103.2	pcf	Use Most Likely Base Values, Except for Variable				
5	Surcharge +	OT & SL	312.5	psf	Use Most Likely Base Values, Except for Variable				
6	Surcharge -	OT & SL	187.5	psf	Use Most Likely Base Values, Except for Variable				
7	Backfill +γ	OT & SL	125.3	pcf	Use Most Likely Base Values, Except for Variable				
8	Backfill -γ	OT & SL	110.7	pcf	Use Most Likely Base Values, Except for Variable				
9	Backfill +Φ	OT & SL	32.8	deg	Use Most Likely Base Values, Except for Variable				
10	Backfill -Φ	OT & SL	27.2	deg	Use Most Likely Base Values, Except for Variable				
11	Backfill +C		66	psf	Use Most Likely Base Values, Except for Variable				
12	Backfill -C		35	psf	Use Most Likely Base Values, Except for Variable				
13	Layer 3 +Φ		30.6	deg	Use Most Likely Base Values, Except for Variable				
14	Layer 3 -Φ		25.4	deg	Use Most Likely Base Values, Except for Variable				
15	Layer 3 +C		66	pcf	Use Most Likely Base Values, Except for Variable				
16	Layer 3 -C		35	pcf	Use Most Likely Base Values, Except for Variable				
17	Layer 3 +γ		100.9	psf	Use Most Likely Base Values, Except for Variable				
18	Layer 3 -γ		89.1	psf	Use Most Likely Base Values, Except for Variable				
19	Layer 4 +Φ	SL	28.4	deg	Use Most Likely Base Values, Except for Variable				**Use values of Case 37 for Layer 7**
20	Layer 4 -Φ	SL	23.6	deg	Use Most Likely Base Values, Except for Variable				**Use values of Case 38 for Layer 7**
21	Layer 4 +C		66	pcf	Use Most Likely Base Values, Except for Variable				**Use values of Case 39for Layer 7**
22	Layer 4 -C		35	pcf	Use Most Likely Base Values, Except for Variable				**Use values of Case 40 for Layer 7**
23	Layer 4 +γ		100.9	psf	Use Most Likely Base Values, Except for Variable				**Use values of Case 41 for Layer 7**
24	Layer 4 -γ		89.1	psf	Use Most Likely Base Values, Except for Variable				**Use values of Case 42 for Layer 7**
25	Layer 5 +Φ		28.4	deg	Use Most Likely Base Values, Except for Variable				**Use values of Case 47 for Layer 8**
26	Layer 5 -Φ		23.6	deg	Use Most Likely Base Values, Except for Variable				**Use values of Case 48 for Layer 8**
27	Layer 5 +C		0	pcf	Use Most Likely Base Values, Except for Variable				**Use values of Case 49 for Layer 8**
28	Layer 5 -C		0	pcf	Use Most Likely Base Values, Except for Variable				**Use values of Case 50 for Layer 8**
29	Layer 5 +γ		104.5	psf	Use Most Likely Base Values, Except for Variable				**Use values of Case 51 for Layer 8**
30	Layer 5 -γ		99.5	psf	Use Most Likely Base Values, Except for Variable				**Use values of Case 52 for Layer 8**
31	Layer 6 +Φ		32.8	deg	Use Most Likely Base Values, Except for Variable				**Use values of Case 57 for Layer 9**
32	Layer 6 -Φ		27.2	deg	Use Most Likely Base Values, Except for Variable				**Use values of Case 58 for Layer 9**
33	Layer 6 +C		0	pcf	Use Most Likely Base Values, Except for Variable				**Use values of Case 59 for Layer 9**
34	Layer 6 -C		0	pcf	Use Most Likely Base Values, Except for Variable				**Use values of Case 60 for Layer 9**
35	Layer 6 +γ		128.9	psf	Use Most Likely Base Values, Except for Variable				**Use values of Case 61 for Layer 9**
36	Layer 6 -γ		121.1	psf	Use Most Likely Base Values, Except for Variable				**Use values of Case 62 for Layer 9**
					Φ	c	γ		
37	Layer 7 +Φ				33.5	1411.2	104.5	Note when doing slope stability	
38	Layer 7 -Φ				30.4	1411.2	104.5	analysis, input these unit wieghts	
39	Layer 7 +C				31.9	1424.1	104.5	for both wet and dry weights.	
40	Layer 7 -C				31.9	1399.0	104.5	(We can do this because our	
41	Layer 7 +γ				31.7	1411.2	109.3	stratum breaks are on the	
42	Layer 7 -γ				32.2	1411.2	99.7	water table line.	
43	Layer 7 Agg +Φ	SL			33.6	1411.2	104.5		
44	Layer 7 Agg -Φ	SL			30.4	1411.2	104.5		
45	Layer 7 Agg +γ				32.2	1411.2	106.2		
46	Layer 7 Agg -γ				31.7	1411.2	102.8		
47	Layer 8 +Φ				33.3	1370.7	110.2		
48	Layer 8 -Φ				30.0	1370.7	110.2		
49	Layer 8 +C				31.6	1370.7	110.2		
50	Layer 8 -C				31.6	1370.7	110.2		
51	Layer 8 +γ				31.5	1370.7	112.2		
52	Layer 8 -γ				31.7	1370.7	108.2		
53	Layer 8 Agg +Φ				33.3	1370.7	110.2	(yellow) No bearing capacity reqd.	
54	Layer 8 Agg -Φ				30.2	1370.7	110.2		
55	Layer 8 Agg +γ				31.9	1370.7	111.9	(cyan) No global stability analysis	
56	Layer 8 Agg -γ				31.4	1370.7	108.5		
57	Layer 9 +Φ				37.1	1370.7	128.8		
58	Layer 9 -Φ				32.7	1370.7	128.8		
59	Layer 9 +C				33.7	1370.7	128.8		
60	Layer 9 -C				33.7	1370.7	128.8		
61	Layer 9 +γ				33.7	1370.7	132.0		
62	Layer 9 -γ				33.8	1370.7	125.6		
63	Layer 9 Agg +Φ				35.1	1370.7	128.8		
64	Layer 9 Agg -Φ				32.6	1370.7	128.8		
65	Layer 9 Agg +γ				33.9	1370.7	130.5		
66	Layer 9 Agg -γ				33.6	1370.7	127.1		
67	Toes Loss				Use Most Likely Base Values, Change Geometry, Compare to MLV Case				

	Base MLVs			Base MLVs		
Layer	Cv	1.094	0.906		1.31	0.69
	Φ	+Φ	-Φ	c	+C	-C
Layer 1	34	37.2	30.8	0	0	0
Layer 2	30	32.8	27.2	50	66	35
Layer 3	28	30.6	25.4	50	66	35
Layer 4	26	28.4	23.6	50	66	35
Layer 5	26	28.4	23.6	0	0	0
Layer 6	30	32.8	27.2	0	0	0
Layer 7	31.9	34.9	28.9	1411	1424	1399
Layer 8	31.6	34.6	28.6	1371	1371	1371
Layer 9	33.7	36.9	30.5	1371	1371	1371
	Cv	1.062	0.938		1.062	0.938
	γ moist	+γ	-γ	γ wet	+γ	-γ
Layer 1	110	116.8	103.2	117	120.4	113.6
Layer 2	118	125.3	110.7	125	128.9	121.1
Layer 3	95	100.9	89.1	102	104.5	99.5
Layer 4	95	100.9	89.1	102	104.5	99.5
Layer 5	95	100.9	89.1	102	104.5	99.5
Layer 6	118	125.3	110.7	125	128.9	121.1
Layer 7				104.5	107.1	101.9
Layer 8				110.2	113.2	107.2
Layer 9				128.8	132.9	124.7

(green) Values used in reliability assessment

	ENGINEERING CONSULTING SERVICES, LTD. COMPUTATION SHEET	*Page*	1 of 1
		Made By	JCG
ECS LLC MID-ATLANTIC	Reliability Assessment	*Date*	10/6/2009
		Checked By	RAK
	Location: Wall 6-RW5A2 Sta 12+40 — Enter Values in Blue.	*Date*	10/6/2009

Type of Analysis Global Stability

Red Values Are Calculated Values.

FS Most Likely Value, F_{MLV}

Factor No.	Variable	OT & Sliding Cases						
1	Most Likely Values		See MLVs below					
2A	High GWT		See MLVs below		+gwt	421.0		
2B	Low GWT		See MLVs below		-gwt	409.0		
			Variable	Units				
3	MSE +γ		116.8	pcf	Use Most Likely Base Values, Except for Variable			
4	MSE -γ		103.2	pcf	Use Most Likely Base Values, Except for Variable			
5	Surcharge +	OT & SL	312.5	psf	Use Most Likely Base Values, Except for Variable			
6	Surcharge -	OT & SL	187.5	psf	Use Most Likely Base Values, Except for Variable			
7	Backfill +γ	OT & SL	125.3	pcf	Use Most Likely Base Values, Except for Variable			
8	Backfill -γ	OT & SL	110.7	pcf	Use Most Likely Base Values, Except for Variable			
9	Backfill +Φ	OT & SL	32.8	deg	Use Most Likely Base Values, Except for Variable			
10	Backfill -Φ	OT & SL	27.2	deg	Use Most Likely Base Values, Except for Variable			
11	Backfill +C		66	psf	Use Most Likely Base Values, Except for Variable			
12	Backfill -C		35	psf	Use Most Likely Base Values, Except for Variable			
13	Layer 3 +Φ		30.6	deg	Use Most Likely Base Values, Except for Variable			
14	Layer 3 -Φ		25.4	deg	Use Most Likely Base Values, Except for Variable			
15	Layer 3 +C		66	pcf	Use Most Likely Base Values, Except for Variable			
16	Layer 3 -C		35	pcf	Use Most Likely Base Values, Except for Variable			
17	Layer 3 +γ		100.9	psf	Use Most Likely Base Values, Except for Variable			
18	Layer 3 -γ		89.1	psf	Use Most Likely Base Values, Except for Variable			
19	Layer 4 +Φ	SL	28.4	deg	Use Most Likely Base Values, Except for Variable			**Use values of Case 37 for Layer 7**
20	Layer 4 -Φ	SL	23.6	deg	Use Most Likely Base Values, Except for Variable			**Use values of Case 38 for Layer 7**
21	Layer 4 +C		66	pcf	Use Most Likely Base Values, Except for Variable			**Use values of Case 39for Layer 7**
22	Layer 4 -C		35	pcf	Use Most Likely Base Values, Except for Variable			**Use values of Case 40 for Layer 7**
23	Layer 4 +γ		100.9	psf	Use Most Likely Base Values, Except for Variable			**Use values of Case 41 for Layer 7**
24	Layer 4 -γ		89.1	psf	Use Most Likely Base Values, Except for Variable			**Use values of Case 42 for Layer 7**
25	Layer 5 +Φ		28.4	deg	Use Most Likely Base Values, Except for Variable			**Use values of Case 47 for Layer 8**
26	Layer 5 -Φ		23.6	deg	Use Most Likely Base Values, Except for Variable			**Use values of Case 48 for Layer 8**
27	Layer 5 +C		0	pcf	Use Most Likely Base Values, Except for Variable			**Use values of Case 49 for Layer 8**
28	Layer 5 -C		0	pcf	Use Most Likely Base Values, Except for Variable			**Use values of Case 50 for Layer 8**
29	Layer 5 +γ		104.5	psf	Use Most Likely Base Values, Except for Variable			**Use values of Case 51 for Layer 8**
30	Layer 5 -γ		99.5	psf	Use Most Likely Base Values, Except for Variable			**Use values of Case 52 for Layer 8**
31	Layer 6 +Φ		32.8	deg	Use Most Likely Base Values, Except for Variable			**Use values of Case 57 for Layer 9**
32	Layer 6 -Φ		27.2	deg	Use Most Likely Base Values, Except for Variable			**Use values of Case 58 for Layer 9**
33	Layer 6 +C		0	pcf	Use Most Likely Base Values, Except for Variable			**Use values of Case 59 for Layer 9**
34	Layer 6 -C		0	pcf	Use Most Likely Base Values, Except for Variable			**Use values of Case 60 for Layer 9**
35	Layer 6 +γ		128.9	psf	Use Most Likely Base Values, Except for Variable			**Use values of Case 61 for Layer 9**
36	Layer 6 -γ		121.1	psf	Use Most Likely Base Values, Except for Variable			**Use values of Case 62 for Layer 9**
					Φ	c	γ	
37	Layer 7 +Φ				33.5	1411.2	104.5	Note when doing slope stability
38	Layer 7 -Φ				30.4	1411.2	104.5	analysis, input these unit wieghts
39	Layer 7 +C				31.9	1424.1	104.5	for both wet and dry weights.
40	Layer 7 -C				31.9	1399.0	104.5	(We can do this because our
41	Layer 7 +γ				31.7	1411.2	109.3	stratum breaks are on the
42	Layer 7 -γ				32.2	1411.2	99.7	water table line.
43	Layer 7 Agg +Φ	SL			33.6	1411.2	104.5	
44	Layer 7 Agg -Φ	SL			30.4	1411.2	104.5	
45	Layer 7 Agg +γ				32.2	1411.2	106.2	
46	Layer 7 Agg -γ				31.7	1411.2	102.8	
47	Layer 8 +Φ				33.3	1370.7	110.2	
48	Layer 8 -Φ				30.0	1370.7	110.2	
49	Layer 8 +C				31.6	1370.7	110.2	
50	Layer 8 -C				31.6	1370.7	110.2	
51	Layer 8 +γ				31.5	1370.7	112.2	
52	Layer 8 -γ				31.7	1370.7	108.2	
53	Layer 8 Agg +Φ				33.3	1370.7	110.2	(yellow) No bearing capacity reqd.
54	Layer 8 Agg -Φ				30.2	1370.7	110.2	
55	Layer 8 Agg +γ				31.9	1370.7	111.9	(cyan) No global stability analysis
56	Layer 8 Agg -γ				31.4	1370.7	108.5	
57	Layer 9 +Φ				37.1	1370.7	128.8	
58	Layer 9 -Φ				32.7	1370.7	128.8	
59	Layer 9 +C				33.7	1370.7	128.8	
60	Layer 9 -C				33.7	1370.7	128.8	
61	Layer 9 +γ				33.7	1370.7	132.0	
62	Layer 9 -γ				33.8	1370.7	125.6	
63	Layer 9 Agg +Φ				35.1	1370.7	128.8	
64	Layer 9 Agg -Φ				32.6	1370.7	128.8	
65	Layer 9 Agg +γ				33.9	1370.7	130.5	
66	Layer 9 Agg -γ				33.6	1370.7	127.1	
67	Toes Loss				Use Most Likely Base Values, Change Geometry, Compare to MLV Case			

	Base MLVs			Base MLVs		
Layer	Cv	1.094	0.906		1.31	0.69
	Φ	+Φ	-Φ	C	+C	-C
Layer 1	34	37.2	30.8	0	0	0
Layer 2	30	32.8	27.2	50	66	35
Layer 3	28	30.6	25.4	50	66	35
Layer 4	26	28.4	23.6	50	66	35
Layer 5	26	28.4	23.6	0	0	0
Layer 6	30	32.8	27.2	0	0	0
Layer 7	31.9	34.9	28.9	1411	1424	1399
Layer 8	31.6	34.6	28.6	1371	1371	1371
Layer 9	33.7	36.9	30.5	1371	1371	1371
	Cv	1.062	0.938		1.062	0.938
	γ moist	+γ	-γ	γ wet	+γ	-γ
Layer 1	110	116.8	103.2	117	120.4	113.6
Layer 2	118	125.3	110.7	125	128.9	121.1
Layer 3	95	100.9	89.1	102	104.5	99.5
Layer 4	95	100.9	89.1	102	104.5	99.5
Layer 5	95	100.9	89.1	102	104.5	99.5
Layer 6	118	125.3	110.7	125	128.9	121.1
Layer 7				104.5	107.1	101.9
Layer 8				110.2	113.2	107.2
Layer 9				128.8	132.9	124.7

(green) Values used in reliability assessment

	ENGINEERING CONSULTING SERVICES, LTD. COMPUTATION SHEET	Page 1 of 1 Made By JCG
ECS LLC MID-ATLANTIC	Reliability Assessment	Date 10/9/2009 Checked By RAK
	Location: **Wall 6-RW5A2 Sta 12+40** Enter Values in Blue.	Date 10/9/2009

Type of Analysis **Slope Stability Circular Overall**

Red Values Are Calculated Values.

FS Most Likely Value, F_{MLV} **1.86**

= ABS(1.80-2.09)

= IF[0.29="","",(0.29/2)^2]

Factor No.		F_i max	F_i Min	Δ F_i	(0.5*Δ F_i)^2
1	GWT	2.09	1.80	0.29	0.0210
2	MSE γ	1.88	1.85	0.03	0.0002
3	Surcharge	1.90	1.84	0.06	0.0009
4	Backfill γ	1.87	1.85	0.02	0.0001
5	Backfill Φ	1.87	1.86	0.01	0.0000
6	Backfill C	1.87	1.87	0.00	0.0000
7	Layer 3 Φ	1.88	1.86	0.02	0.0001
8	Layer 3 C	1.88	1.87	0.01	0.0000
9	Layer 3 γ	1.88	1.86	0.02	0.0001
10	Layer 4&7 Φ	1.91	1.84	0.07	0.0012
11	Layer 4&7 C	1.88	1.86	0.02	0.0001
12	Layer 4&7 γ	1.87	1.87	0.00	0.0000
13	Layer 5&8 Φ	1.92	1.82	0.10	0.0025
14	Layer 5&8 C				
15	Layer 5&8 γ	1.88	1.86	0.02	0.0001
16	Layer 6&9 Φ	1.88	1.83	0.05	0.0006
17	Layer 6&9 C				
18	Layer 6&9 γ	1.87	1.87	0.00	0.0000
19	Layer 7 Agg Φ	1.88	1.86	0.02	0.0001
20	Layer 7 Agg γ	1.87	1.87	0.00	0.0000
21	Layer 8 Agg Φ	1.88	1.86	0.02	0.0001
22	Layer 8 Agg γ	1.87	1.87	0.00	0.0000
23	Layer 9 Agg Φ	1.87	1.87	0.00	0.0000
24	Layer 9 Agg γ	1.87	1.87	0.00	0.0000
25	Toe Loss +High GWT	1.77			
26					
27					
28					
29					
30					
31					
32					
33					
34					
35					

Σ		0.0272	= SUM(0.0210 to 0)
Standard Deviation FS	σ_F =	0.17	= 0.0272^0.5
Coefficient of Variation	V_F =	0.0888	= 0.17/1.86
Lognormal Reliability Index	B_L =	6.9618	= {LN[1.86/(1+0.0888^2)^0.5]}/{[LN(1+0.0888^2)]^0.5}
Probability of Failure	PF =	0.00%	= [1-NORMSDIST(6.9618)]

RAK	ENGINEERING CONSULTING SERVICES, LTD. COMPUTATION SHEET	Page 1 of 1
ECS LLC MID-ATLANTIC	Reliability Assessment	Made By JCG
		Date 10/9/2009
		Checked By RAK
	Location: Wall 6-RW5A2 Sta 12+40 — Enter Values in Bl	Date 10/9/2009

Type of Analysis **Slope Stability Circular Lower Slope** Red Values Are Calculated Values.

FS Most Likely Value, F_{MLV} **1.5**

= ABS(1.27-1.71)

= IF[0.44="","",(0.44/2)^2]

Factor No.		F_i max	F_i Min	Δ F_i	(0.5*Δ F_i)^2
1	GWT	1.71	1.27	0.44	0.0484
2	MSE γ	1.50	1.50	0.00	0.0000
3	Surcharge	1.50	1.50	0.00	0.0000
4	Backfill γ	1.51	1.50	0.01	0.0000
5	Backfill Φ	1.50	1.50	0.00	0.0000
6	Backfill C	1.51	1.50	0.01	0.0000
7	Layer 3 Φ	1.50	1.50	0.00	0.0000
8	Layer 3 C	1.50	1.50	0.00	0.0000
9	Layer 3 γ	1.50	1.50	0.00	0.0000
10	Layer 4&7 Φ	1.57	1.44	0.13	0.0042
11	Layer 4&7 C	1.56	1.45	0.11	0.0030
12	Layer 4&7 γ	1.52	1.49	0.03	0.0002
13	Layer 5&8 Φ	1.58	1.43	0.15	0.0056
14	Layer 5&8 C				
15	Layer 5&8 γ	1.51	1.50	0.01	0.0000
16	Layer 6&9 Φ	1.50	1.50	0.00	0.0000
17	Layer 6&9 C				
18	Layer 6&9 γ	1.50	1.50	0.00	0.0000
19	Layer 7 Agg Φ	1.50	1.50	0.00	0.0000
20	Layer 7 Agg γ	1.50	1.50	0.00	0.0000
21	Layer 8 Agg Φ	1.50	1.50	0.00	0.0000
22	Layer 8 Agg γ	1.50	1.50	0.00	0.0000
23	Layer 9 Agg Φ	1.50	1.50	0.00	0.0000
24	Layer 9 Agg γ	1.50	1.50	0.00	0.0000
25	Toe Loss +High GWT	1.35			
26					
27					
28					
29					
30					
31					
32					
33					
34					
35					

Σ		0.0616	= SUM(0.0484 to 0)
Standard Deviation FS	σ_F =	0.25	= 0.0616^0.5
Coefficient of Variation	V_F =	0.1654	= 0.25/1.5
Lognormal Reliability Index	B_L =	2.3855	= {LN[1.5/(1+0.1654^2)^0.5]}/{[LN(1+0.1654^2)]^0.5}
Probability of Failure	PF =	0.85%	= [1-NORMSDIST(2.3855)]

English Version

I-495 - MSE Walls
Project No. 14487

Reliability
Wall 6RW5A Sta 12+40
Wet Conditions as MLV — assumes std dev = 1/6 of change between full pore pressure and no pore pressure.
2 :1 Slope Below
(use 0 for flat)

Normal Water Table at Toe of Wall? NO

STABILITY CALCULATIONS FOR
MECHANICALLY-STABILIZED EARTH WALLS

BACKFILL and Base MATERIAL
α (deg) 0
MSE Fill ϕ (deg) 34.0
Backfill (deg) 30.0
MSE Fill (kcf) 0.1000
Backfill Density (kcf) 0.1180
Base Soil Density (kcf) 0.0998
Surcharge 250 psf

Reliability Std Deviations		+	-	
Surcharge	(250 ± 25%)	1.25	0.75	
Unit Weight	± 5.7%	1.062	0.938	
Bouyant Weight	±6.7%	1.062	0.938	
Φ	± 9.4%	1.094	0.906	
Cohesion	±31.0%	1.31	0.69	Use 250 if initial C = 0
GWT	Dry - Wet	Dry	Wet	

Reliability Assessment

By: RAK Date: 10/9/2009
Checked: JCG Date: 10/9/2009

Analysis Case	Base Variable	Changed Variable	Phi used for Sliding Φ	Backfill (deg)	MSE Fill (pcf)	Backfill Density (pcf)	GWT (Yes/No)	Surcharge	Cohesion C for sliding psf	Cohesion C for Bearing psf	Base Φ for Bearing Capacity deg	Base Unit Weight pcf	MSE Wall Height H[2] ft	Active Soil Force P Plus 250 psf surcharge kip	Weight of Soil Mass per foot, W Plus 250 psf surcharge kip	Effective Base of MSE B=0.7 H ft	Depth of Embedmt. D_f[3] ft	Active Earth Pressure Coefficnt. Ka
Initial Analysis (most likely values)	Green shaded boxes are affected by change in variables.		31.9	30	110	118	No	250	100	730.5	29.0	99.8	13.0	4.4	15.3	9.1	2.0	0.33
Low GWT EL 409.0 ft	No	GWT	31.9	30	110	118	No	250	100	730.5	29.0	99.8	13.0	4.4	15.3	9.1	2.0	0.33
High GWT EL 421.0 ft	No	GWT	31.9	30	110	118	No	250	100	714.8	29.1	89.5	13.0	4.4	15.3	9.1	2.0	0.33
Layer 1 MSE Fill, -δ	110	116.8	31.9	30	116.82	118	No	250	100	730.5	29.0	99.8	13.0	4.4	16.1	9.1	2.0	0.33
Layer 1 MSE Fill, +δ	110	103.2	31.9	30	103.18	118	No	250	100	730.5	29.0	99.8	13.0	4.4	14.5	9.1	2.0	0.33
Surcharge, +	250	312.5	31.9	30	110	118	No	312.5	100	730.5	29.0	99.8	13.0	4.7	15.9	9.1	2.0	0.33
Surcharge, -	250	187.5	31.9	30	110	118	No	187.5	100	730.5	29.0	99.8	13.0	4.1	14.7	9.1	2.0	0.33
Layer 2 Backfill, - Unit Weight	118	125.3	31.9	30	110	125.32	No	250	100	730.5	29.0	99.8	13.0	4.6	15.3	9.1	2.0	0.33
Layer 2 Backfill, + Unit Weight	118	110.7	31.9	30	110	110.68	No	250	100	730.5	29.0	99.8	13.0	4.2	15.3	9.1	2.0	0.33
Layer 2 Backfill, + Φ	30	32.8	31.9	32.82	110	118	No	250	100	730.5	29.0	99.8	13.0	3.9	15.3	9.1	2.0	0.30
Layer 2 Backfill, - Φ	30	27.2	31.9	27.18	110	118	No	250	100	730.5	29.0	99.8	13.0	4.9	15.3	9.1	2.0	0.37
Layer 4, +Φ, Case 19, 37	26	28.4	33.5	30	110	118	No	250	100	730.5	29.9	99.8	13.0	4.4	15.3	9.1	2.0	0.33
Layer 4, - Φ Case 20, 38	26	23.6	30.4	30	110	118	No	250	100	730.5	27.0	99.8	13.0	4.4	15.3	9.1	2.0	0.33
layer 4, +δ Case 23, 41	95	100.9	31.9	30	110	118	No	250	100	730.5	29.0	105.1	13.0	4.4	15.3	9.1	2.0	0.33
layer 4, -δ Case 24, 42	95	89.1	31.9	30	110	118	No	250	100	730.5	29.0	94.4	13.0	4.4	15.3	9.1	2.0	0.33
layer 4, + C Case 21, 39	50	65.5	31.9	30	110	118	No	250	100	745.0	29.0	99.8	13.0	4.4	15.3	9.1	2.0	0.33
layer 4, - C Case 22, 40	50	34.5	31.9	30	110	118	No	250	100	717.0	29.0	99.8	13.0	4.4	15.3	9.1	2.0	0.33
Layer 7, Agg +Φ, Case 43	45	59.0	33.6	30	110	118	No	250	100	730.5	29.8	99.8	13.0	4.4	15.3	9.1	2.0	0.33
Layer 7, Agg -Φ, Case 44	45	31.1	30.4	30	110	118	No	250	100	730.5	28.2	99.8	13.0	4.4	15.3	9.1	2.0	0.33
layer 7,Agg +δ Case 45	95.00	100.9	31.9	30	110	118	No	250	516	730.5	29.0	101	13.0	4.4	15.3	9.1	2.0	0.33
layer 7, Agg -δ Case 46	95.00	89.1	31.9	30	110	118	No	250	516	730.5	29.0	99.7	13.0	4.4	15.3	9.1	2.0	0.33

Analysis Case	FACTOR OF SAFETY AGAINST OVERTURNING: Mo incl surcharge ft-kip	Mr =(B/2)*W ft-kip	F.S.overturn =Mr/Mo	FACTOR OF SAFETY AGAINST SLIDING: For Sands at base of Wall Tan ϕ	For Sands: Force Resisting Sliding kip	For Clays at Base of Wall: Force Resisting Sliding Kips	Total F.S.	FACTOR OF SAFETY AGAINST BEARING CAPACITY: Eccentricity e ft	Toe Bearing Stress q_{toe} psf	Heel Bearing Stress q_{heel} psf	Avg Bearing Stress W/(L-2e) psf	Surcharge Coefficient Nq Not used per AASHTO Myerhoff	Friction Coefficent Ng Meyerhoff	Cohesion Coefficient Nc Meyerhoff	Effective B B'=B-2e ft	Ultimate Bearing Capacity qult ksf	FSbc =qult/qavg	CHECKS: FSot >2?	FSslid >1.5?	FSbc >2.5?	Eccentricity B/2 - e < B/6 ?	Eccentricity e < B/6 ?
Initial Analysis (most likely values)	21.4	69.6	3.24	0.62	9.4	0.9	2.33	1.40	3,231	129	2,427	0.00	9.85	20.92	6.30	18379	7.57	YES	YES	YES	YES	YES
Low GWT EL 409.0 ft	21.4	69.6	3.24	0.62	9.4	0.9	2.33	1.40	3,231	129	2,427	0.00	9.85	20.92	6.30	18379	7.57	YES	YES	YES	YES	YES
High GWT EL 421.0 ft	21.4	69.6	3.24	0.62	9.4	0.9	2.33	1.40	3,231	129	2,427	0.00	9.85	20.92	6.30	17730	7.31	YES	YES	YES	YES	YES
Layer 1 MSE Fill, -δ	21.4	73.2	3.41	0.62	9.9	0.9	2.44	1.33	3,320	218	2,499	0.00	9.85	20.92	6.44	18446	7.38	YES	YES	YES	YES	YES
Layer 1 MSE Fill, +δ	21.4	65.9	3.07	0.62	8.9	0.9	2.22	1.48	3,144	38	2,359	0.00	9.85	20.92	6.14	18300	7.76	YES	YES	YES	YES	YES
Surcharge, +	23.2	72.1	3.11	0.62	9.7	0.9	2.26	1.46	3,420	65	2,566	0.00	9.85	20.92	6.18	18320	7.14	YES	YES	YES	YES	YES
Surcharge, -	19.7	67.0	3.40	0.62	9.0	0.9	2.41	1.34	3,047	188	2,293	0.00	9.85	20.92	6.42	18438	8.04	YES	YES	YES	YES	YES
Layer 2 Backfill, - Unit Weight	22.3	69.6	3.11	0.62	9.4	0.9	2.23	1.46	3,297	63	2,474	0.00	9.85	20.92	6.18	18320	7.41	YES	YES	YES	YES	YES
Layer 2 Backfill, + Unit Weight	20.6	69.6	3.38	0.62	9.4	0.9	2.44	1.34	3,164	196	2,381	0.00	9.85	20.92	6.42	18438	7.74	YES	YES	YES	YES	YES
Layer 2 Backfill, + Φ	19.1	69.6	3.64	0.62	9.4	0.9	2.62	1.25	3,065	295	2,316	0.00	9.85	20.92	6.60	18526	8.00	YES	YES	YES	YES	YES
Layer 2 Backfill, - Φ	24.0	69.6	2.90	0.62	9.4	0.9	2.08	1.57	3,419	-59	2,565	0.00	9.85	20.92	5.96	18211	7.10	YES	YES	YES	YES	WARNING: CHECK ECCENTRICITY
Layer 4, +Φ, Case 19, 37	21.4	69.6	3.24	0.66	10.0	0.9	2.47	1.40	3,231	129	2,427	0.00	10.80	21.95	6.30	19430	8.01	YES	YES	YES	YES	YES
Layer 4, - Φ Case 20, 38	21.4	69.6	3.24	0.59	8.8	0.9	2.21	1.40	3,231	129	2,427	0.00	8.22	18.86	6.30	16361	6.74	YES	YES	YES	YES	YES
layer 4, +δ Case 23, 41	21.4	69.6	3.24	0.62	9.4	0.9	2.33	1.40	3,231	129	2,427	0.00	9.85	20.92	6.30	18543	7.64	YES	YES	YES	YES	YES
layer 4, -δ Case 24, 42	21.4	69.6	3.24	0.62	9.4	0.9	2.33	1.40	3,231	129	2,427	0.00	9.85	20.92	6.30	18211	7.50	YES	YES	YES	YES	YES
layer 4, + C Case 21, 39	21.4	69.6	3.24	0.62	9.4	0.9	2.33	1.40	3,231	129	2,427	0.00	9.85	20.92	6.30	18682	7.70	YES	YES	YES	YES	YES
layer 4, - C Case 22, 40	21.4	69.6	3.24	0.62	9.4	0.9	2.33	1.40	3,231	129	2,427	0.00	9.85	20.92	6.30	18096	7.46	YES	YES	YES	YES	YES
Layer 7, Agg +Φ, Case 43	21.4	69.6	3.24	0.66	10.0	0.9	2.47	1.40	3,231	129	2,427	0.00	10.80	21.95	6.30	19430	8.01	YES	YES	YES	YES	YES
Layer 7, Agg -Φ, Case 44	21.4	69.6	3.24	0.59	8.8	0.9	2.21	1.40	3,231	129	2,427	0.00	8.99	19.89	6.30	17356	7.15	YES	YES	YES	YES	YES
layer 7,Agg +δ Case 45	21.4	69.6	3.24	0.62	9.4	4.7	3.19	1.40	3,231	129	2,427	0.00	9.85	20.92	6.30	18416	7.59	YES	YES	YES	YES	YES
layer 7, Agg -δ Case 46	21.4	69.6	3.24	0.62	9.4	4.7	3.19	1.40	3,231	129	2,427	0.00	9.85	20.92	6.30	18376	7.57	YES	YES	YES	YES	YES

NOTES: 1. Unit Weights determined from Table below
2. H given in specs as Top of MSE wall caping minus Top of Leveling Pad.
3. D_f given in specs as Finish grade in Top of Leveling Pad
4. All walls considered to have a surcharge load simulating traffic load at top of the wall.
5. Ø = f(Soil Type, N); see formulae below.
6. Phi is based on spt correlations to VDOT ACRA values.
7. C is based on SPT correlations to VDOT ARCA values. Do not use for SP or GP at base.
8. Assumes level base and level backfill.
9. Do not use C below WT except for CTA

ANALYSIS OF MSE RETAINING WALLS

Surcharge for traffic is normally equal to a 0.6 m high fill above wall.

Average stress is computed over a distance = B - 2e.

B = 0.7H for normal situations, min = 2.4 m

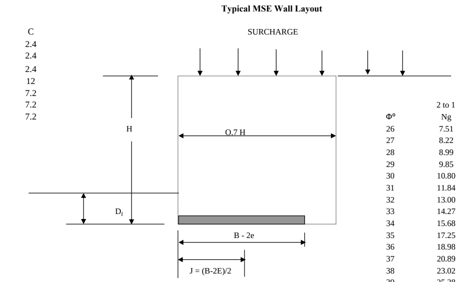
Surcharge for traffic normally is 250 psf (12 KPa) or 0.6 m of fill

Df is typically 2 feet (0.6m) See Requirements.

VDOT Exhibit N Values

	Γ_{dry}	Γ_{wet}	Phi	C
II-A	15.2	16.3	28	2.4
II-B	18.9	20	30	2.4
II-C	20.8	21.9	32	2.4
III	19.2	20.5	34	12
T-I	16.8	17.9	26	7.2
T-II	18.4	19.5	30	7.2
T-III	20	21.1	34	7.2

Typical MSE Wall Layout



Φ°	2 to 1 Ng	3 to 1 Ng	Flat Ng	2 to 1 Nc	3 to 1 Nc	Flat Nc
26	7.51	9.12	12.53	17.83	18.41	22.25
27	8.22	10.49	14.46	18.86	20.77	23.93
28	8.99	12.07	16.71	19.89	21.95	25.79
29	9.85	13.89	19.33	20.92	23.13	27.85
30	10.80	15.99	22.39	21.95	24.31	30.13
31	11.84	18.4	25.98	24.71	27.53	32.66
32	13.00	21.18	30.20	27.47	30.75	35.47
33	14.27	24.39	35.17	30.23	33.97	38.62
34	15.68	28.08	41.04	32.99	37.19	42.14
35	17.25	32.33	48.00	35.75	40.41	46.10
36	18.98	37.23	56.27	38.51	43.63	50.56
37	20.89	42.88	66.14	41.27	46.85	55.60
38	23.02	49.39	77.97	44.03	50.07	61.32
39	25.38	56.89	92.17	46.79	53.29	67.83
40	27.99	65.54	109.32	49.55	56.51	75.27

	ENGINEERING CONSULTING SERVICES, LTD. COMPUTATION SHEET	Page 1 of 1	
		Made By	JCG
ECS LLC MID-ATLANTIC	Reliability Assessment	Date	10/9/2009
		Checked By	rah
	Location: **Wall 6-RW5A2 Sta 12+40** Enter Values in Blue.	Date	10/9/2009

Type of Analysis **Bearing Capacity**

Red Values Are Calculated Values.

FS Most Likely Value, F_{MLV} **7.57**

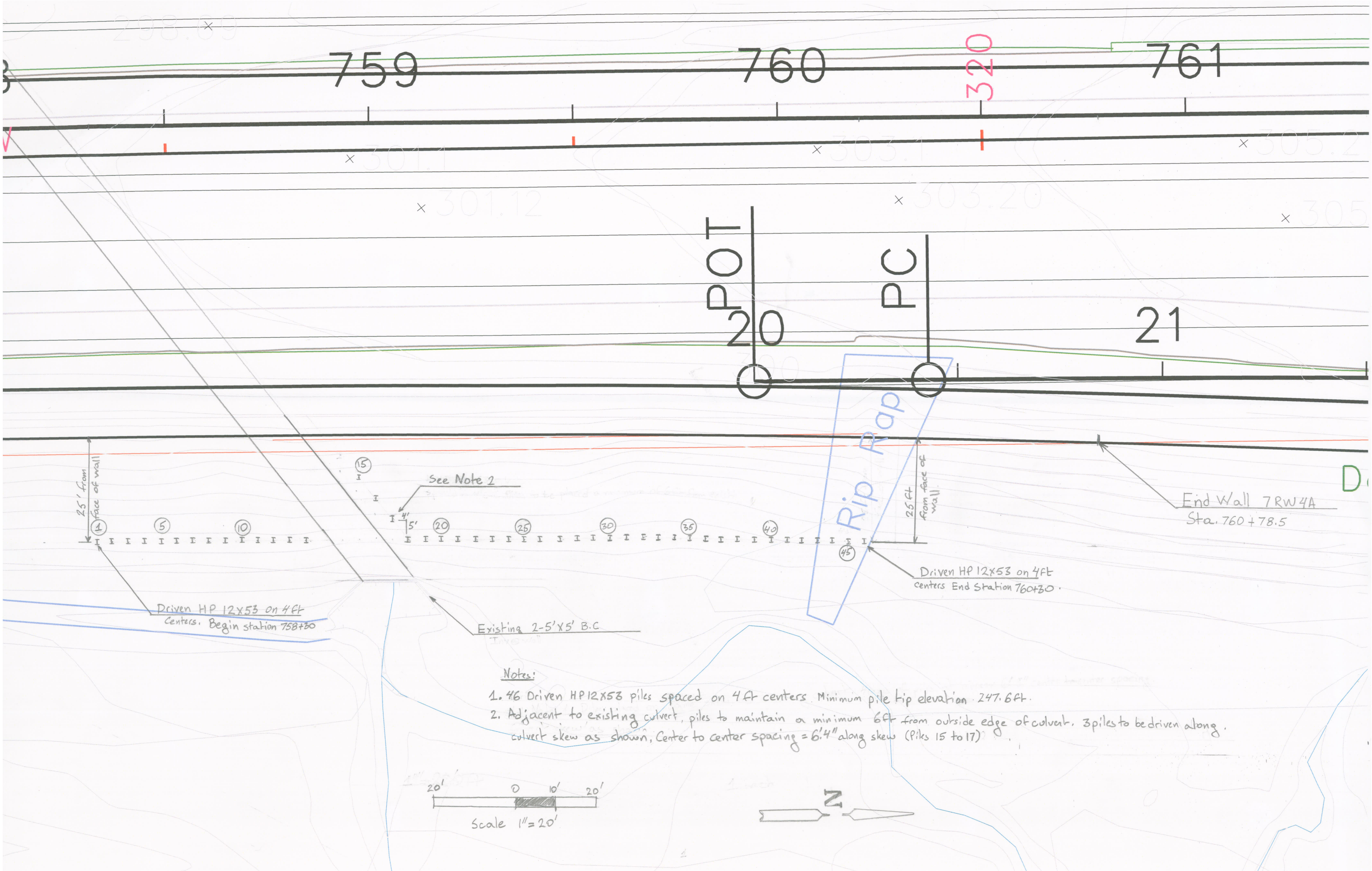
= ABS(7.31-7.57)

= IF[0.26="","",(0.26/2)^2]

Factor No.		F_i max	F_i Min	γ Fi	(0.5*γ Fi)^2
1	GWT	7.57	7.31	0.26	0.0169
2	MSE γ	7.76	7.38	0.38	0.0361
3	Surcharge	8.04	7.14	0.90	0.2025
4	Backfill γ	7.41	7.34	0.07	0.0012
5	Backfill Φ	8.00	7.10	0.90	0.2025
6	Layer 4 Φ	8.01	6.74	1.27	0.4032
7	Layer 4 γ	7.64	7.50	0.14	0.0049
8	Layer 4 C	7.70	7.46	0.24	0.0144
9	Layer 7 Agg Φ	8.01	7.15	0.86	0.1849
10	Layer 7Agg γ	7.59	7.57	0.02	0.0001
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					
31					
32					
33					
34					
35					

Σ		1.0668	= SUM(0.0169 to 0)
Standard Deviation FS	σ_F =	1.03	= 1.0668^0.5
Coefficient of Variation	V_F =	0.1364	= 1.03/7.57
Lognormal Reliability Index	B_L =	14.8368	= {LN[7.57/(1+0.1364^2)^0.5]}/{[LN(1+0.1364^2)]^0.5}
Probability of Failure	PF =	0.00%	= [1-NORMSDIST(14.8368)]


RW-4A MULTI-IMPROVMENTS
12. 11. 2006


759
760
320
761
POT
PC
20
21
Rip Rap
25' from face of wall
25 ft from face of wall
See Note 2
4'
5'
1
5
10
15
20
25
30
35
40
45
End Wall 7RW4A
Sta. 760+78.5
Driven HP 12X53 on 4ft centers. Begin station 758+30
Driven HP 12X53 on 4ft centers End Station 760+30.
Existing 2-5'X5' B.C
Notes:
1. 46 Driven HP12X53 piles spaced on 4ft centers. Minimum pile tip elevation 247.6ft.
2. Adjacent to existing culvert, piles to maintain a minimum 6ft from outside edge of culvert. 3 piles to be driven along culvert skew as shown, Center to center spacing = 6'4" along skew (Piles 15 to 17).
20'
0
10'
20'
Scale 1"=20'
N


12.11.2006

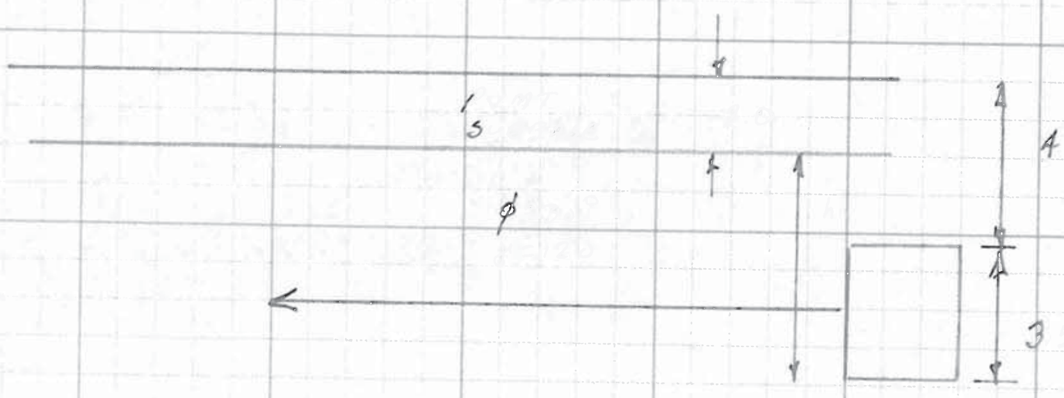

12.11.2006

ECS
14026 Thunderbolt Place, Suite 100
Chantilly, VA 20151-3296
T: 703-471-8400
F: 703-834-5527

CALCULATION SHEET

PROJECT: HOT LANES	FIGURE NO. 1/1
TITLE: ARW7A	JOB NO.
	SCALE:
BY: JCG / DATE: 9-7-11 / APPROVED BY. RA	DATE 9-8-11

Determination of anchor capacity at temp condition (No pvmt)



$h = 3.5 + (4.25 - 2.0) = 5.75$

$L = 6.0$

$\phi = 30^\circ \quad k_p = 3.0 \quad k_a = 0.33$

$P = 0.5 \times 120 \times 5.75^2 \times (3.0 - 0.33) \times 6.0$

$= 31.8 \text{ kips} > 25.0 \quad \text{ok}$

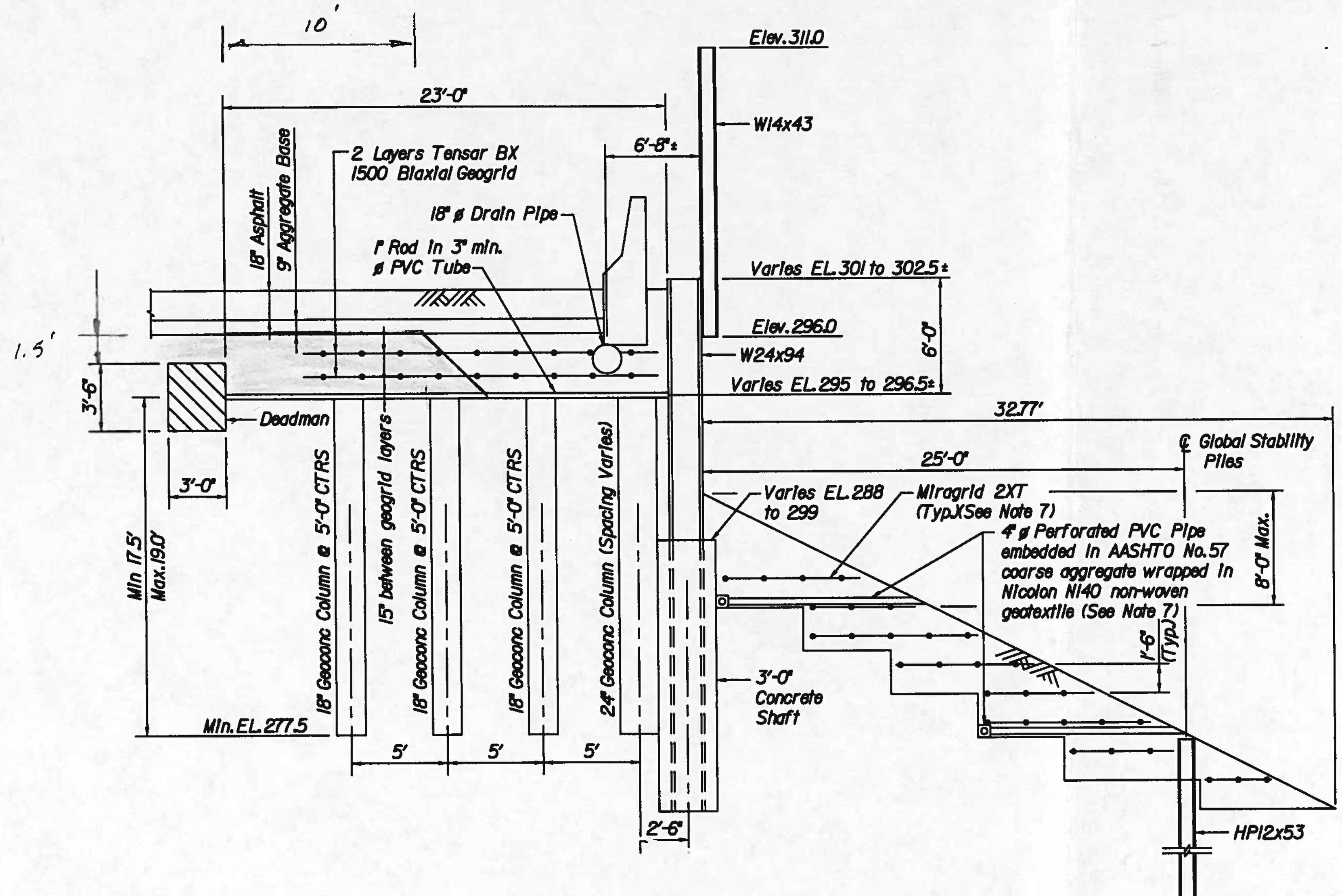
IP_PWPdms22632\D368094-RW18(D).dgn
[1-22,24-51,54,53,58,56,60-64,66]

LIMITED ACCESS HIGHWAY — By Resolution of Highway Commission Dated October 4, 1956

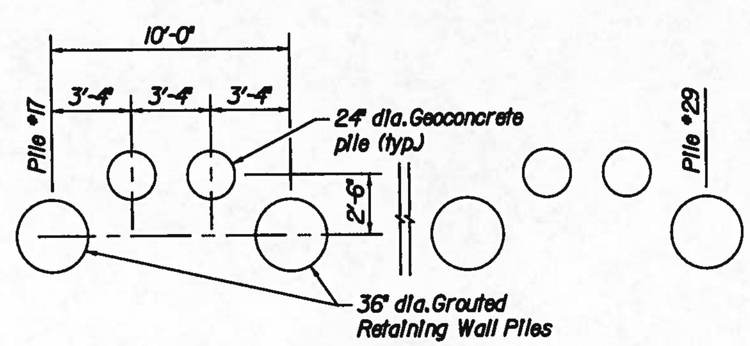
REVISION	DATE	FHWA REGION	STATE	FEDERAL AID PROJECT	STATE ROUTE	STATE PROJECT	SHEET NO.
0	2011-07-20	3	VA.		495	0495-029-754, P101 0495-029-138, R201 0495-029-754, C501	4-RW18(D)

PROJECT MANAGER — LARRY CLOYED (571) 483-2600
SURVEYED BY — RICHARD ZIENS (703) 631-5325
DESIGN SUPERVISED BY — CHARLES A. DODGE (703) 824-5100
DESIGNED BY — HNTB CORPORATION (703) 824-5100

DRAFT



TYPICAL SECTION GEO CONC COLUMNS
STA.759+60 TO 760+90
Not To Scale



SSPACING DETAILS - 24" DIA. PILES
Not To Scale

Note:
Two 24" dia. Geoconrete pilets located between each 36" dia. Retaining Wall grouted pile.

$P_p = 0.5 \times 0.126 \times 3.0 \times 5^2 \times 6.0 = 28$ kips

Construction Notes:

1. Excavate working bench 6'-0" below top of retaining wall piles.
2. Construct geoconcrete columns
3. Excavate deadman pits and concrete deadman.
4. Install anchor rods, ~~tension to wall designer requirements~~
5. ~~Following completion of deadman installation and partially back face backfill to top of deadman installing first layer of Tensar geogrid.~~
6. Remove existing fill in front of posts to firm ground (i.e., DCP ≥ 10) and to a minimum of 6 ft or maximum of 8 ft. If competent material is not encountered at 8 ft, notify The Collin Group (301-907-9501). Bench excavation as shown.
7. Install drainage system. Daylight every 20 feet.
8. Backfill with approved select fill (SM, SP, or better material with less than 35% fines and an effective friction angle of 30°). Compact to 95% standard proctor density. Backfill lifts 9 inches maximum.
9. Install geogrid reinforcement every 1'-6" vertically. Geogrid to extend from face of slope to excavated face. Install electrical conduit at approximate elevation.
10. Protect slope face with temporary erosion blanket until vegetation is established.
11. Front slope repair shown at Post #7 is representative of repair limits. Elevations, toe offset, grade of slope, and post size varies.
12. Miragrid 2XT and Nicolon NI40 (or equivalents) will require QC Approval.
13. ~~Backfill behind wall to underside of road pavement, installing second geogrid layer.~~
14. Complete roadway construction.

5. Install fill & geogrid in front of anchor as shown in 7.5" thick lifts. See shaded area.
5b. Tension deadman anchors to 20.0 kips
13. Fold back geogrids. Place remaining fill and grid in 7.5-in thick lifts to roadway subgrade
15. check anchor tension Lock off at 26.0 kips

Rev.	Date	Description
0	2011-07-20	FDC 0938 - Slope Remediation

FLUOR-LANE
I-495 HOT LANES
RETAINING WALL
Details

HNTB — HNTB CORPORATION, ARCHITECTS ENGINEERS & PLANNERS, ARLINGTON, VIRGINIA

Scale	Date			
	December 05, 2008			
PLAN NO.	PROJECT		FILE NO.	SHEET NO.
A	0495-029-754			4-RW18(D)

IP_PWPdms22632\D368094-RW18(D).dgn
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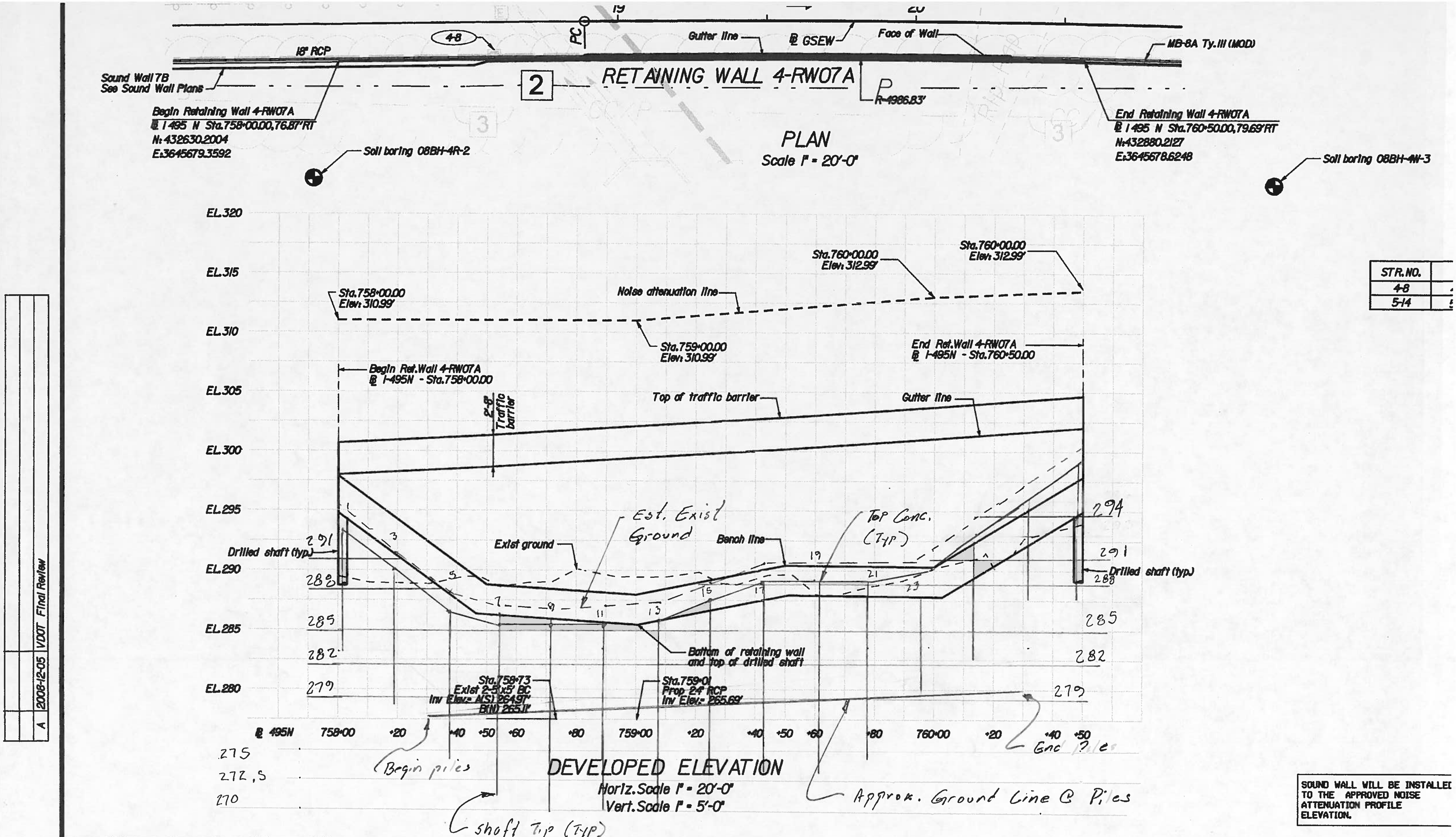
Project - PW-36809
Pen Table - \\Alxw00\Caddlib\Mstn\Workspace\Agency\VDOT_V8i\Pltd\ProjectFiles\36809\Hwy-36809_H.pen



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Project = PW-36809
Pen Table = \\Alxw00\Caddlib\Mstn\Workspace\Agency\VDOT\Plot\ProjectWise\36809\Hwy-36809_H.pen

WHY DID WALL MOVE?

TECHNICAL FOUNDATIONS INCORPORATED

Auger Cast Pile Drill Rig

Chassis:
Bantam hyd. Excavator w/ fixed mast

Power Unit:
GM Diesel

Rotary Drive:
Staffa Motor, variable speed w/ torque up to 17K ft.-lb. w/ max. 70 rpm

TKB Series

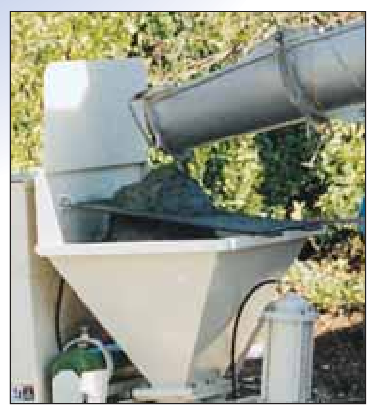
Hydraulic Ball Valve Thom-Katt® Pumps

1

TKB 60 shown

2

3



4

TKB 45

These units are ideal for masonry grouting, stem walls, patios, sidewalks, precast toppings and more.

TKB 60

A steady concrete flow (without pulsation) makes these pumps perfect for residential and commercial jobs.

TKB 80

The high volume TKB 80 fills a niche in accommodating the cast auger piling contractors' needs.

1 2 Lufkin 3 RUGGED 4 RED END 5 ENGINEERS 6 7 8 9 10 11


NEXT
110


RW-7A SOIL NAIL WALL FAILURE

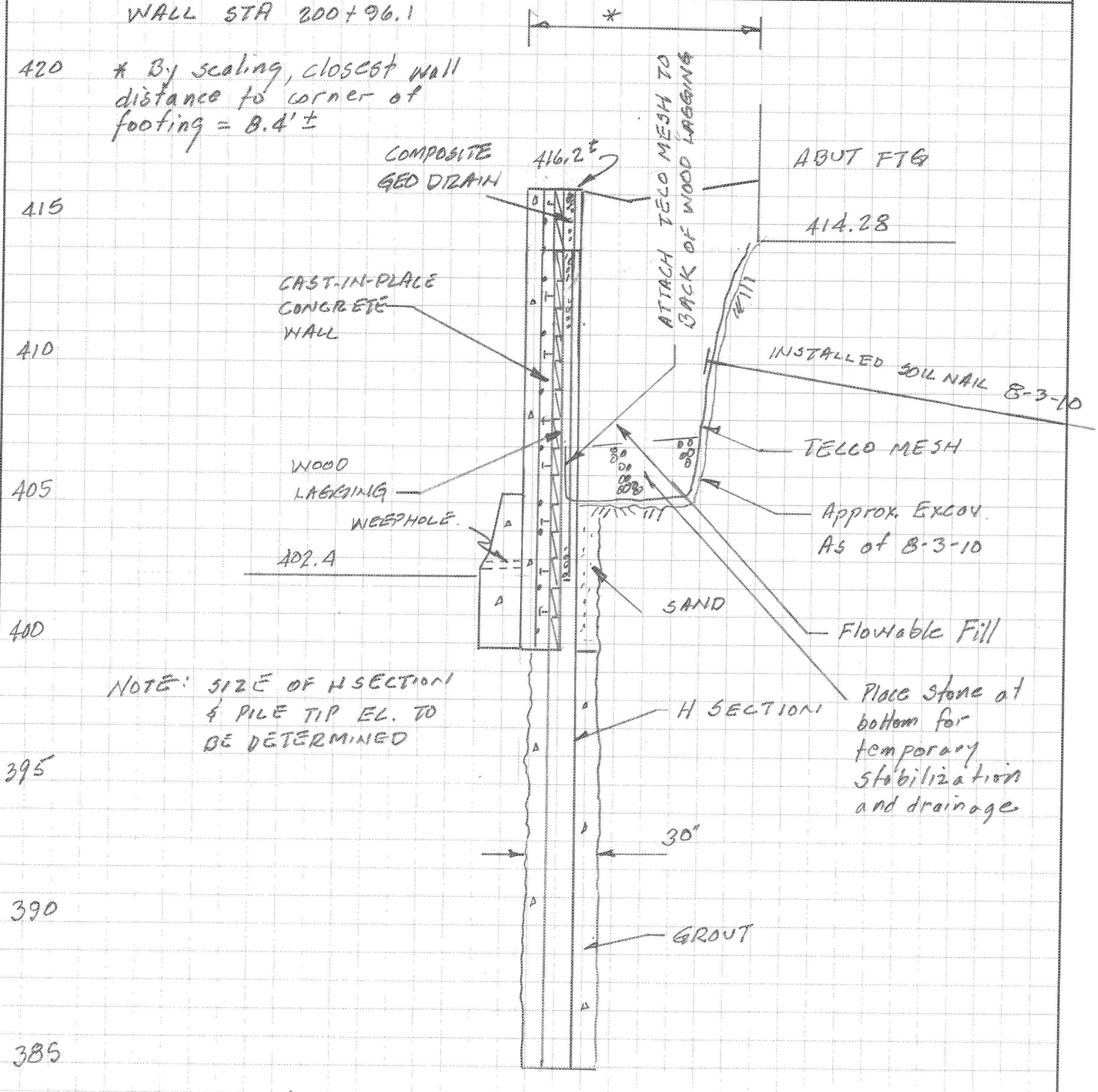
ECS LLC MID-ATLANTIC

CALCULATION SHEET

PROJECT: HOT LANES			FIGURE NO.
TITLE: WALL 7-RW7 200+70 to 201+15 CIP WALL PRELIM DETAIL			JOB NO.
			SCALE:
BY: JCG	DATE: 8-4-10	APPROVED BY:	DATE

WALL STA 200+96.1

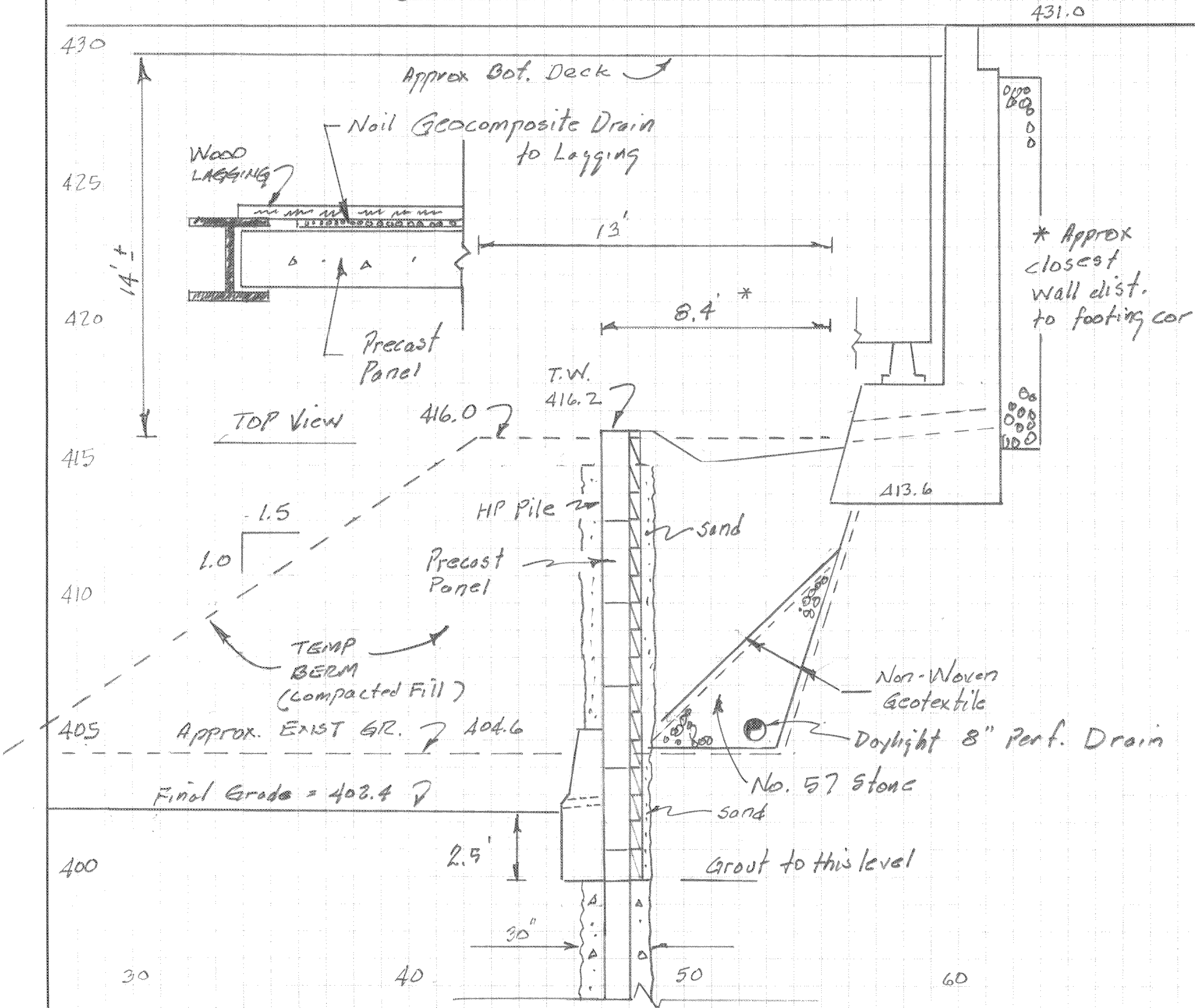
* By scaling, closest wall distance to corner of footing = 8.4' ±



NOTE: SIZE OF H SECTION & PILE TIP EL. TO BE DETERMINED

SCALE 1" = 5'

SECTION @ WALL STA 200+96



ECS LLC
MID-ATLANTIC
CALCULATION SHEET

PROJECT: HOT LANES

TITLE: WALL 7-RW7 200+70 to 201+15
TEMP. BERM & PRELIM P&P DETAIL

BY: JCG

DATE: 8-10-10

APPROVED BY:

FIGURE NO.

JOB NO. NDC 496

SCALE: 1" = 5'

DATE 70.

PIER REINFORCING CALCULATIONS

Unit weight (pcf)	118				
Angle of int. friction (deg.)	30	0.523599	(rad.)	Kp =	3
Load factor on pile driving force, FS		1.5			
Diameter of piers, D (ft.)		2.5			
Center-center spacing of piers, S (ft.)		7			
Grade of reinforcing steel (ksi)		60			

SECTION	FS	Fr	Fd	Fp	Depth to fail. surf (ft)	Pl min. (Ft)	Pl (SS) (Ft)
F-F	1.133	39213	34619	89009	6	8.2	14.2
	1.179	46061	39058	87682	6	8.1	14.1
	1.210	51629	42662	86548	6	8.1	14.1
	1.215	51632	42491	84732	6	8.0	14.0
	1.165	39565	33967	79699	6	7.7	13.7
	1.250	56373	45087	78803	6	7.7	13.7
	1.219	48053	39413	77466	6	7.6	13.6
	1.240	52620	42447	77354	6	7.6	13.6
	1.214	45306	37317	74687	6	7.5	13.5
	1.129	31914	28272	73458	6	7.4	13.4
	1.152	33985	29490	71750	6	7.4	13.4
	1.237	47306	38240	70378	6	7.3	13.3
				89009		MAX:	14.2
					Shaft length required =		8.2

Depth to failure surface is measured from top of pier.
"Pl(min)" = MIN. LENGTH OF PIER BELOW FAILURE SURFACE REQ'D TO DEVELOP PASSIVE PRESS.
"Pl(SS)" = Pl(min) + DEPTH OF FAILURE SURFACE BELOW TOP OF PIER

Req'd Pier Force>>> Fp = S*[FS*(Fd)-Fr] (FS=1.50)

Pier Length (Below Failure Surface) Req'd for Passive Resistance:
Pl min. = (Fp/(1.5*Gamma*D*Kp)^-1/2
Fp = 1.5*Gamma'*Lp^2*D*Kp (Pier Design Manual)

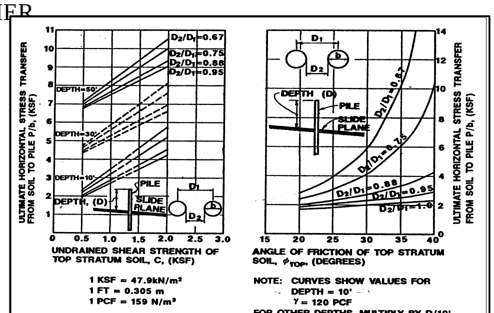


Figure 7.44 Ultimate stress transfer from soil to piles versus shear strength of soil (from Pearlman and Withiam, 1992, reproduced by permission of ASCE).

SOIL SQUEEZE BETWEEN PIERS EVALUATION

Based on above entered data, distance D1 (ft.)	7	and diameter (b) (ft.)	2.5
Depth to sliding plane, D (ft.)	6		
Hence, distance D2 (ft.)	4.5	and ratio D2/D1	0.6429
Ratio P/b from Fig. 7.44 of Abramson et. al.	6	Hence, load transfer to piers (klf)	90
Max force on piers currently at S ft, Fp (k/Sft)	89.01	Hence, piers could span up to (ft)	7.078
Spacing	OK!		

I-495 H.O.T. Lanes
7-RW7
FAIRFAX COUNTY, VA

GENERAL NOTES

This plan shows the permanent support of excavation work required for construction of Retaining Walls 7-RW7 on the I-495 H.O.T. Lanes Project in Fairfax County, VA. Only those portions of the work necessary to clarify the work of Schnabel Foundation Company have been shown. The following procedures should be followed closely.

DESIGN CRITERION

a) Design soil parameters were derived from the worst case soil conditions in MACTEC Geotechnical Report dated April 2, 2009.
b) Soldier Piles shall be completely galvanized as corrosion protection.
c) Wind Loads for noise walls are based on AASHTO recommendations for 80 mph wind.
d) Design per VDOT, FHWA and AASHTO recommendations as applicable.

CONSTRUCTION SEQUENCE

Pre-Construction

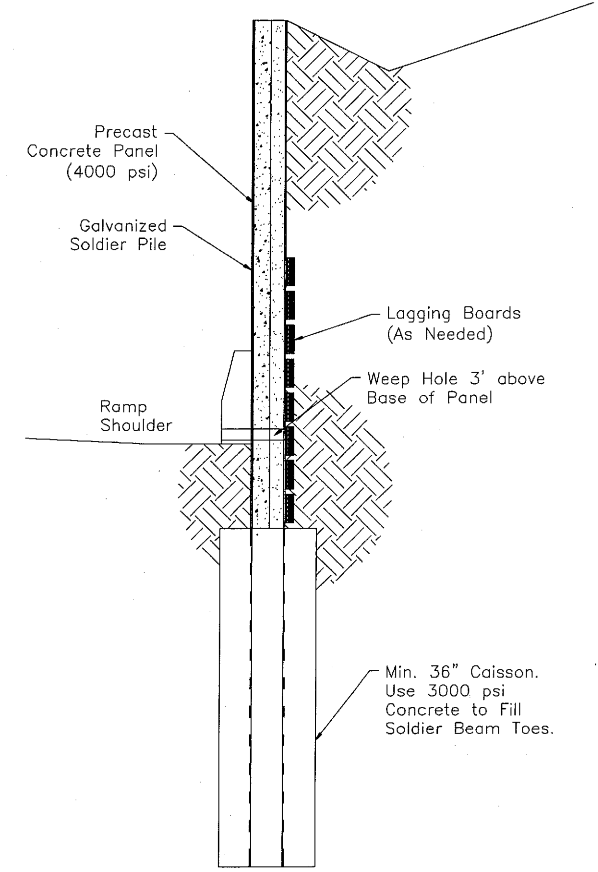
a) Verify location and depth of adjacent utilities and modify the soldier beam layout as required. Contact "MISS-UTLITY" 1-800-257-7777 to locate all utilities in the adjacent area prior to any work.
b) Excavate the site to top of pile elevation or lower. (by others)
c) Prepare site for soldier beam installation by providing a firm level bench at least 50 feet in width at the top of the soldier beams (by others).
d) Layout shoring line with stations at a minimum of every fifty feet and all corners; for radius walls, each pile shall be laid out. (by others)

Shoring

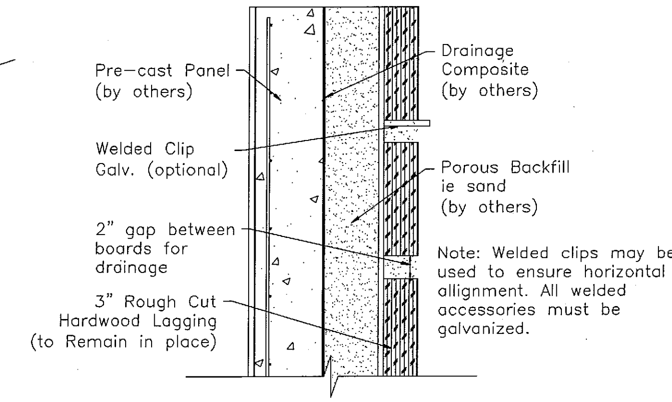
e) Layout each soldier beam as shown on the design drawings.
f) Predrill 36" holes for soldier beams as shown on the design drawings. Ensure holes are free of excessive loose material and water before installing piles. Holes shall be drilled with temporary casing if required to keep hole open. Drilled hole conditions should be checked just before filling with grout. 3000psi concrete shall be poured up to bottom of wall elevation. Lean mix shall be used to fill remainder of drill hole.
g) If excessive groundwater is entering the drilled shaft, drill to required shaft depth and allow groundwater to stabilize in the drilled shaft. When concrete arrives on-site, groundwater will be pumped out of drilled shaft, concrete will be placed and followed with placement of steel post in plastic concrete. If the top of concrete elevation is lower than 6" below bottom of panel, additional concrete shall be placed while concrete is still plastic.
h) If soil and groundwater conditions prevent forming a non-caving drilled shaft, the drilled shaft will be permanently cased with galvanized steel lining. The steel lining will have an inside diameter equal or larger than the required foundation shaft diameter. The steel lining may be placed in the partially drilled shaft, rotated, and drilled until a sufficient bottom elevation is achieved to reduce the flow of water to a manageable level. The steel lining may or may not extend to the bottom of the drilled shaft. If required, excess spoil will be removed from inside the lining to achieve planned bottom of shaft elevation.
i) If visible voids develop outside the steel lining, flowable fill will be used to fill voids outside the lining as required.

No pile excavation shall be made within a clear distance of 8 feet from an open pile shaft, nor within a clear distance of 4 feet from a pile which had its concrete encasement in place for less than 12 hours unless shafts are stable.
j) Excavate in lifts not to exceed 5 feet (less if soil will not stand open) and install wood lagging to 2 feet below the tieback locations indicated on the tieback schedule (by others).
k) Continue excavation in lifts not to exceed 5 feet until the bottom of excavation is reached.
l) Remove excess concrete in caissons to allow placement of panels at the correct elevation. Leveling and tamping of earth for panel installation by others.
m) Install Pre-Cast Panels and Backfill to final elevation (by others).
n) Install noise wall connections and allow 48 hour cure time before setting posts. Install noise wall posts in locations shown on drawings.
o) A post splice will be executed as required at a locations above the planned top of concrete elevation to allow for installation of posts in two (2) sections where required. Note that two (2) splices may be required for the tallest posts.

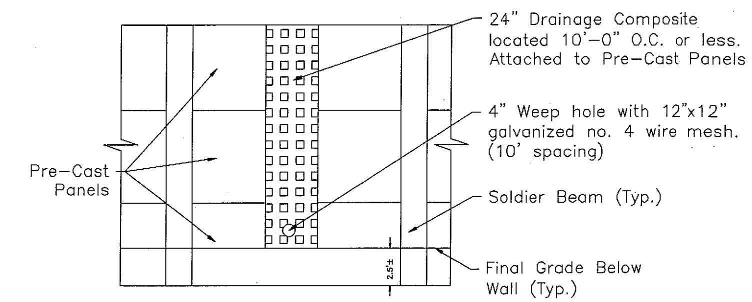
MATERIALS
Steel:
High Strength Bolts: ASTM A325 – Galvanized.
Nuts: ASTM A536 DH – Galvanized
Washers: ASTM F436 – Galvanized
All Other Steel: ASTM A572 Grade 50 – Galvanized, U.O.N.
Tiebacks: Grade 270 strand to ASTM A-416 (7-wire pre-stress strand) with double corrosion protection.
Lagging Boards: Nominal 3" thick mixed hardwood
Concrete: 3000psi soldier beam toes, N.W. Post Connections.
Flowable fill remainder of drilled holes.
Precast Panels shall use 4000psi 28 day strength
Grout: Type I/Type II cement Conforming to section 218 of VDOT Specifications
Drainage Composite: Minimum rating – 10 gpm at hydraulic gradient of 0.1 to ASTM D476. Textile fabric shall be bonded to both sides of drainboard.



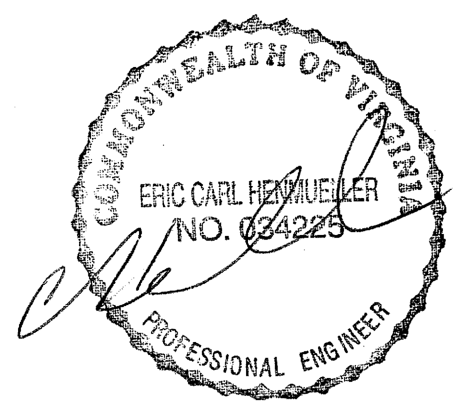
Standrdard Section
N.T.S.



Drainage Detail
(Cut Condition) N.T.S.



Drainage Detail
View from Back of Panel N.T.S.



REVISIONS

Eric C Henmueller, PE P.E. VA # 034225

I-495 H.O.T. LANES 7-RW7
FAIRFAX COUNTY, VA
NOTES & DETAILS

Schnabel
FOUNDATION COMPANY
Engineers and Contractors
5210 River Rd., BETHESDA, MD (301) 657-3060
Fax (301) 657-4080
ATLANTA • BOSTON • CHICAGO • DENVER
HOUSTON • PHILADELPHIA • SAN FRANCISCO

X

Date: 11.16.10	Scale: N.T.S.
Drawn By: DRS	Dwg. No.: 1 of 4


12.03.2006


STRUCTURAL
ENGINEER

Must Haves for Success

- Experienced (old) PM
- Experienced deep foundations expert (almost as old)
- Experience in similar work and scale
- Geotechnical experience with State DOT
- Large committed full-time staff
- Recognize not all will be productive
- Willingness to accept the review process
- Staff is local & co-located
- Do not overburden PM (share responsibility)
- Pathways for productivity
  - Training
  - Calculation templates
  - Report templates
  - Monitoring
  - QA

Any Questions?